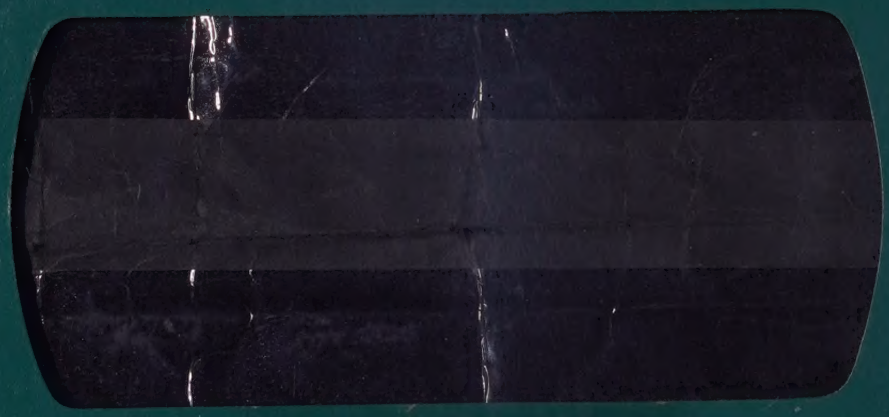
communications

MP MASTER
MA32499



Regn # X102-2717
Items - 6

General Installation

Transmitter

Receiver

Power Supply

Control Equip.

Access. and Misc.

INSTRUCTIONS

for

PROGRESS LINE

144-174 Megacycle
50-Watt

STATION COMBINATIONS
PO36WR6 & PO36BR6

EBI-41697
Special

2-WAY MOBILE RADIO

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC
LYNCHBURG, VIRGINIA

Printed in U.S.A.

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Production Change Sheet EBI-41210
Specification Sheet ECR-234
Description and Maintenance EBI-41067
Service Outline D-7668899
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Elementary Diagram
Parts List

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Instructions EBI-41061 (Special)
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PROGRESS LINE 144-174 MC STATION COMBINATIONS

General Electric Progress Line Station Combinations are identified by a combination number which describes the standard units and accessories required for an installation. A complete station combination designation consists of two letters, followed by a SERIES number and one or two additional letters.

Desk-Mate Station

Example:

VO-16-NR

Cabinet Designator
- **D** — Desk-Mate Cabinet
- **P** — Pole-Mount Cabinet
- **V** — Vertical 69-Inch Cabinet
- **R** — Auxiliary Receiver Cabinet

Control Designator
- **E** — Extended Local Control
- **K** — Local/Remote Control
- **R** — Remote Control
- **Y** — Automatic Repeater and Relay Operation

Note — No control designator is used for locally-controlled stations

Power Supply Designator
- **O** — 117-Volt a-c, Continuous-Duty Power Supply

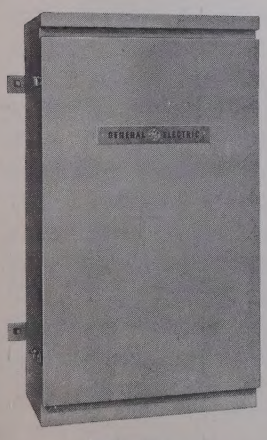
Station Combination Series Designator

25-54 Megacycles
- **10** — Auxiliary Receiver
- **16** — High Power (75-Watt)
- **17** — Super Power (100-Watt)
- **18** — Very High Power (250-Watt)

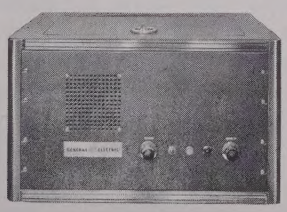
144-174 Megacycles
- **30** — Auxiliary Receiver
- **36** — High Power (50-Watt)
- **38** — Very High Power (250-Watt)

450-470 Megacycles
- **40** — Auxiliary Receiver
- **42** — City Power (15-Watt)

Receiver Bandwidth Designator
- **W** — Wide Band
- **N** — Narrow Band



Pole-Mount Weatherproof Station



Auxiliary Receiver Station

250 Watt 50-100 Watt

69-Inch Vertical Stations

Printed in U.S.A.

EQUIPMENT INDEX

Equipment	Series 30	Series 36	Series 38
1. Cabinet			
a) Auxiliary Receiver Cabinet 7484114-P2	1		
b) 50-Watt Station Cabinets		1	
1) Desk-Mate Cabinet 7150329-G1			
2) 69-Inch Vertical Cabinet 7775161-G5			
3) Pole-Mount Cabinet 7132483-G3			
c) 250-Watt, 69-Inch Vertical Cabinet 7775161-G6			1
2. Transmitter			
a) 50-Watt Transmitter		1	1
4ET21A1 (144-152 Mc, 1-Freq)			
4ET21A2 (152-174 Mc, 1-Freq)			
4ET21A11 (144-152 Mc, 2-Freq)			
4ET21A12 (152-174 Mc, 2-Freq)			
b) 250-Watt Power Amplifier 4EF1A2 (Uses Transmitter ET-21-A, listed above, as Exciter)			1
		R	R
3. Receiver	1	1	1
a) Narrow Band (30-kc channels)			
4ER25A1 (144-152 Mc, 1-Freq)			
4ER25A2 (152-174 Mc, 1-Freq)			
4ER25A11 (144-152 Mc, 2-Freq)			
4ER25A12 (152-174 Mc, 2-Freq)			
b) Wide Band (60-kc channels)			
4ER25B1 (144-152 Mc, 1-Freq)			
4ER25B2 (152-174 Mc, 1-Freq)			
4ER25B11 (144-152 Mc, 2-Freq)			
4ER25B12 (152-174 Mc, 2-Freq)			
4. Power Supplies			
a) Receiver Power Supply 4EP3A1	1	1	1
b) Transmitter Power Supply 4EP4A2		1	1
c) 250-Watt Power Amplifier Power Supply 7666209-G1			1
5. Blower Kit 7146797-G1 (Required for continuous duty of Transmitter ET-21-A)		F	F
6. Cabinet Blower and Filter Kit 7144429-G1 (Required for continuous duty of 250-watt stations)			F
7. Auxiliary Receiver Mounting 7772956-G6	1		
8. Meter Shield 7483552-P3			1
9. Safety Handle 7145676-P1 (for PO combinations only)		1	
10. Antenna Filter Mounting Panel 7144813-P1			1
11. Low-Pass Filter 4KY4A11			1
12. Antenna-Matching Unit Mounting Bracket 7145084-G1			R
13. Antenna-Matching Unit 4KY8C1		R	R
14. Cabinet Heater Kit 4KZ3A1 (for pole-mount combinations only)		J	
			R
15. 3½-Inch Blank Panel 7146959-P2 (PO and VO combinations only)		1	2
16. Transmitter Heated Crystal Kit 7142674-G1		J2T	J2T
17. Receiver Heated Crystal Kit 7150775-G1	J2R	J2R	J2R
18. RF Cables			
		R	
a) 10-Inch RG-58/U, Phono to Phono 7488600-P24 (Transmitter to Receiver)		1	1
b) 16-Inch RG-58/U, Phono to UHF 7474980-G33 (Transmitter to Receiver without Antenna-Matching Unit)		R	
c) 30-Inch RG-58/U, Phono to UHF 7474980-G32 (Transmitter to Antenna-Matching Unit)		R	
d) 17-Inch RG-58/U, UHF to UHF 7474980-G29		R	R
e) 13-Inch RG-58/U, UHF to UHF 7474980-G28		R	R
f) 22-Inch RG-58/U, UHF to UHF 7474980-G30 (used in VO combinations only)		R	
g) 33-Inch RG-58/U, UHF to UHF 7474980-G31			1
h) 18-Inch RG-8/U, UHF to UHF 7474980-G1			1
i) 24-Inch RG-8/U, UHF to UHF 7474980-G24			1
19. UHF Connectors			
			R
a) Right-Angle Connector M-2R22-P2	1		2
b) Antenna Cable Connector M-2R22-P1	1	1	
c) T-Connector M-2R22-P5		R	R
20. 6-Inch Hi-Output Speaker 4EZ3B1		S2	S2
21. Desk-Mate Power Connection			
a) Power Cord 7147492-G1		1	
b) Plug Adapter 7160486-G1		1	
22. Wiring Harness			
a) For 2nd Receiver 7132520-G3		R	R
b) For 2nd and 3rd Receivers 7132520-G4 (for VO combinations only)		R	
23. Local Control Equipment*			
a) Local Control Panel 4KC4C1 (VO combinations only)		1	1
b) Controlled-Reluctance Desk Mike 4EM9B1 (DO and VO combinations only)		1	1
c) 20-Foot Microphone Extension Cable 7487021-G3 (VO combinations only)		1	X
d) Footswitch 4KC1C1		X	X
e) Speaker 4EZ1B1 (VO combinations only)		R	R
		1	1
f) Cabinet 2-Freq Switch Kit 7144791-G1 (except PO combinations)	A2	A2	A2
g) Desk-Mate Cabinet Control Panel 7669301-G1 (DO combinations only)		1	
h) Power Supply Modification Kit 7147811-G1 (DO combinations only)		2	

Equipment	Series 30	Series 36	Series 38
24. Remote Control Equipment*			
a) Remote Control Panel 4KC7B1		1	1
b) Speaker 4EZ1B1		1	1
c) Remote Control Overlay Harness 7147091-G2		1	1
d) Controlled-Reluctance Military Mike 4EM10A1		1	1
e) Control Panel 2-Freq Transmitter or 2-Transmitter Kit 7143269-G1		A	A
f) Control Panel 2-Receiver Kit 7143269-G2		A	A
g) Control Panel 2-Freq Receiver Kit 7143269-G3		A	A
h) Relay-Polarizing Kit 7145278-G1		A	A
i) Intercom Kit 7488796-G1 (requires M3)		C5	C5
j) Carbon Telephone Handset 4EM11A1		M3	M3
k) Grille and Nameplate Kit 7150332-G1 (for DO combinations only)		1	
25. Local/Remote Control Equipment (DO combinations only)*			
a) Remote Control Panel 4KC7B1		1	1
b) Controlled-Reluctance Desk Mike 4EM9B1		1	1
c) 20-Foot Microphone Extension Cable 7487021-G3		X	X
d) Footswitch 4KC1C1		X	X
e) Cabinet 2-Freq Switch Kit 7144791-G1		A2	A2
f) Desk-Mate Cabinet Control Panel 7669301-G1, 3 or 5		1	1
g) Power Supply Modification Kit 7147811-G1		2	2
h) Remote Control Overlay Harness 7147091-G2		1	1
i) Control Panel 2-Freq Transmitter or 2-Transmitter Kit 7143269-G1		A	A
j) Control Panel 2-Receiver Kit 7143269-G2		A	A
k) Control Panel 2-Freq Receiver Kit 7143269-G3		A	A
l) Relay-Polarizing Kit 7145278-G1		A	A
m) Intercom Kit 7488796-G1 (requires M3)		C5	C5
n) Carbon Telephone Handset 4EM11A1		M3	M3
26. Relay Station Control Equipment*			
a) Repeater Control Panel 4KC48I		1	1
b) Repeater Control Panel 4KC10A2 (for use with tone equipment)		X	X
c) Carrier-Operated Relay 7486775-G2		1	1
d) Cathode-Follower Kit 7144882-G1		1	1
e) 3-Minute Timer Kit 7144902-G1		C1	C1
f) Transmitter Drop-Out-Delay Kit 7144901-G2		C2	C2
g) Compensating Network Narrow Band 7150715-G2 or Wide Band 7150715-G1		1	1
h) Tone Receiver (1-Tone) 7489113-G1		L	L
i) Tone Receiver (2-Tone) 7489112-G1		L	L
j) Speaker 4EZ1A1		1	1
k) Controlled-Reluctance Military Mike 4EM10A1		1	1
l) Repeater Control Overlay Harness 7147091-G1		1	1
m) Receiver Rear Shield 7144420-G1		1	1
n) Transmitter Blower Kit 7146797-G1		1	1
o) Cabinet Blower and Filter Kit 7144429-G1			1
p) Grille and Nameplate Kit 7150332-G1 (for DO combinations only)		1	
27. Extended-Local Control Equipment*			
a) Local Control Panel 4KC4C1 (PO and VO combinations only)		1	1
b) Controlled-Reluctance Desk Mike 4EM9B1		1	1
c) Extended-Local Control Unit 4EC31A1		1	1
d) 25-Foot Control Cable 7489233-G1		1	1
e) 50-Foot Control Cable 7489233-G2		X	X
f) Power Supply Modification Kit 7147811-G1		2	2
g) 2nd Receiver Control Kit 7144389-G1		R	R
h) 2nd Receiver Control Cable (25-Foot) 7147427-G1		R	R
i) 2nd Receiver Control Cable (50-Foot) 7147427-G2		R	R
j) Grille and Nameplate Kit 7150332-G1 (for DO combinations only)		1	
k) 2-Freq Kit 7146329-G1		A2	A2
28. Alignment Tool 7144890-P1	1	1	1
29. Optional Microphones			
a) Controlled-Reluctance Military Mike 4EM10A1		M2	M2
b) Carbon Telephone Handset 4EM11A1 (requires M9)		M3	M3
c) Carbon Hangup Handset 4MKD3A4 (requires M9)		M4	M4
d) Controlled-Reluctance Handset 4EM12A1		M5	M5
e) Controlled-Reluctance Desk Mike 4EM8B1		M6	M6
f) Swinging-Arm Dynamic Mike 4EM13A1		M7	M7
g) Carbon Mike Modification Instructions 7147201		M9	M9
30. Carrier-Operated Relay 7486775-G2		B	B
31. Tone Squelch Kit		K	K
32. Tone Combinations			
a) Single-Tone, Tone Transmitter Combination		X	X
b) Single-Tone, Group-Calling Combination		X	X
c) Single-Tone, Selective-Signalling Combination		X	X
d) Two-Tone, Selective-Signalling Combination		X	X
e) 10, 72 or 100-Call Tone Transmitter Combination		X	X

* Only one combination of control equipment is furnished.

A Multiple-frequency options.
B Carrier-operated relay option.
C Control options.
F Blower options.
J Cabinet heater option.
L Tone options.
M Microphone options.
R Multiple receiver options.
X Optional equipment.

INSTALLATION INSTRUCTIONS FOR PROGRESS LINE STATION COMBINATIONS

All rack wiring in station cabinets and the installation of option kits is normally completed according to the customer's specifications before the General Electric Progress Line Station Combinations are shipped. Instructions are given below for installing the cabinet and making the antenna, power and control connections.

CABINET INSTALLATION

The only requirements for the mounting location of the station cabinet are that the cabinet be installed close to the antenna transmission line and a source of line voltage, and that sufficient room be available to open the cabinet for servicing.

DESK-MATE CABINET

In Local Control and Local/Remote Control Installations, the Desk-Mate cabinet contains a control panel installed into the front end of the cabinet. This panel is replaced by a grille and nameplate panel in Extended Local, Remote and Relay controlled combinations. The locally-controlled Desk-Mate cabinet is assembled for mounting on the right side of a desk; i.e., mounting the cabinet against the right side of a desk permits easier, quicker service facility, since the top sides of the chassis are accessible from the right side of cabinet. If it is desired to locate the cabinet against the left side of a desk, the Control Panel may be switched to the opposite end of the cabinet, thereby permitting access to the top sides of the chassis from the left side of the cabinet. To disengage the Control Panel, remove the two screws, lockwashers and nuts securing the top of the panel to the cabinet and the two self-tapping screws (located from inside cabinet) which secure the bottom of the panel to the cabinet. When disengaged, pull the panel slightly forward, swing it 90° vertically and pass through the opening and in back of the cabinet rack to the opposite end of the cabinet. Disengage the grille located at the back end of cabinet by removing the four screws, lockwashers nuts and replace with the Control Panel. Assemble the grille in the space formerly occupied by the Control Panel.

FLOOR-MOUNT CABINET

The floor-mount cabinet is provided with mounting holes in the baseplate for anchoring the cabinet to the floor. Dimensions of the cabinet may be determined from Installation Diagram C-7775341 (see Table of Contents). Sufficient space should be available in front of and behind the cabinet to permit opening both the front and the rear doors. If desired, either door may be removed, inverted and hinged on the opposite side.

POLE-MOUNT CABINET

The pole-mount cabinet is provided with two mounting straps for mounting the cabinet on cross arms between two telephone poles, on the crossarms of a single pole or on some other vertical mounting surface, using four 1/2-inch bolts. It is suggested that the front of the pole-mount cabinet face away from the prevailing wind. Dimensions of the cabinet may be determined from Installation Diagram M-7485209 (see Table of Contents).

POWER AND GROUND CONNECTIONS

Both the stations cabinet and its relay rack should be grounded to a good earth ground to protect service personnel and to minimize hum currents. Check the resistance to ground with an ohmmeter to be sure that the rack and cabinet are well grounded.

DESK-MATE STATION

The Local and Local/Remote controlled desk-mate stations are provided with a 10-foot power cable (W901) with plug, to connect to a 117-volt a-c convenience outlet. The terminal end of this cable should be passed through one of the three cable entry ports, located on either side of the cabinet below the access doors, and connected between terminals C and D of the control panel power switch S901. In Remote and Repeater stations, this connection is made to terminals 1 and 2 of TB704 on the Control Panel. The power cable is not used for Extended Local Control stations, since power is brought in from the Extended-Local Control Unit. After the power cable connections are made, the conductor which is common to wire 313, wire 1 and wire 3 of the wiring harness should be common to the ground or neutral side of the building wiring system.

FLOOR-MOUNT STATION

Three knockouts are provided on the rear side of the base of the floor-mount cabinet for the entrance of conduit, BX cable or rubber-covered cable for power. If the power cable entrance is through conduit coming up through the floor, the cabinet may be set over the end of the conduit, which is allowed to project into the cabinet through one of the two 7-inch by 17-inch openings in the baseplate of the cabinet.

Make the 117-volt a-c power connections at terminals 1 and 2 of terminal board TB704 on the control panel. Be sure that terminal 1 is connected to the ground or neutral side of the building wiring system. This places all unfused power leads at ground potential.

POLE-MOUNT STATIONS

Installation of a pole-mount station will require drilling a hole in the cabinet for the entrance of the power line. Make the 117-volt a-c power connections at terminals 1 and 2 of terminal board TB704 on the control panel. Be sure that terminal 1 is connected to the ground or neutral side of the power line. This places all unfused power leads at ground potential.

ANTENNA CONNECTION

Install the antenna and its transmission line according to the instructions supplied with the antenna equipment. The system will not perform satisfactorily if the antenna is not placed in accordance with good engineering practice.

For combinations which include an Antenna Matching Unit, refer to the Antenna Matching Unit instructions for antenna connections. In two-receiver combinations which have no Antenna Matching Unit, a VHF "T" connector, M-2R22-P5, is provided. This connector is fastened to the ANT jack, J512, located on the rear of the Station Receiver Power Supply. A 16-inch section of RG-58/U is connected between the "T" connector and the REC connector on the Transmitter chassis. A 13-inch section of RG-58/U is connected between the remaining section of the "T" connector and the ANT jack, J512, located on the rear of the 2nd Receiver Power Supply.

DESK-MATE STATIONS

Pass the RG-8/U transmission line from the antenna through one of the cable entry ports located on either side

of the cabinet below the access door and connect to the ANT jack (J512) on the Transmitter Power Supply chassis.

FLOOR-MOUNT STATIONS

An opening has been provided in the top of the floor-mounted cabinet for the entrance of RG-8/U transmission line. There is a cable clamp for the cable just inside the opening and a punched plate for changing the size of the opening to fit the cable. Connect the antenna lead to the ANT jack (J512) on the Transmitter Power Supply chassis in 50-watt stations, or to the Low-Pass Filter in 250-watt stations.

POLE-MOUNT STATIONS

A hole will be required in the pole-mount cabinet for the entrance of transmission line. The line will usually terminate at the cabinet, using the end seal to pass into the cabinet. The RG-8/U lead from the end seal adapter should be connected to the ANT jack (J512) on the Transmitter Power Supply chassis.

CONTROL CONNECTIONS

LOCAL CONTROL

Connect the microphone to the MICROPHONE jack (J509) on the Transmitter Power Supply chassis, and locate the microphone in a position convenient to the dispatcher. The local control Desk-Mate station incorporates a control panel which includes a microphone jack to be used for this connection if preferred. The microphone location may be inside the cabinet, on the side of the cabinet or on the dispatcher's desk. A 20-foot microphone extension cable is available for use if the microphone or microphone jack is to be located several feet away from the transmitter.

Mount the speaker in a location which will direct the sound to the dispatcher. 25 feet of cable is provided so that the speaker may be located at some distance from the receiver. Connect the speaker cable between terminals 9 and 10 of terminal board TB501 on the Receiver Power Supply chassis. The local Control Desk-Mate station incorporates a built-in speaker.

EXTENDED-LOCAL CONTROL

Connect the microphone to MICROPHONE jack J701, located on the bottom of the EC-31-A control unit, and locate the

microphone in a position convenient to the dispatcher. The control unit is supplied with 25 feet of control cable. However, 50 feet of cable is available as an option, so the control point can be located up to 50 feet away from the station transmitter - in a different room or at a different floor level. The control cable is connected to the equipment as shown below:

1. Carefully pry the back cover from the base of the Extended-Local Control Unit.

2. Remove the four screws inside the back of the case which hold the control unit to the base.

3. Mount the 21-pin male connector, which is on the end of the control cable, at the left side of the rectangular opening inside the back of the base, using the two screws present. Install the connector so that the contacts face forward.

4. Connect the 21-pin female connector, which is inside the control unit, to the connector-installed in the preceding step, and screw the control unit back onto the base.

5. Clamp the control cable under the empty cable clamp inside the rear of the base.

6. Replace the back cover on the base by pressing the push rivets into the proper holes in the base.

REMOTE CONTROL

Instructions for connecting the Remote Control Unit to the telephone line are included in the separate instruction book for the Control Unit.

Mount the microphone at a convenient location inside the cabinet, or on the side of the Desk-Mate or floor-mount cabinet. On Pole-Mount or Floor-Mount cabinets connect the microphone to jack J509 on the Transmitter Power Supply chassis. The Desk-Mate local control panel incorporates a microphone jack for this purpose.

The floor-mount and pole-mount stations are provided with a speaker to be mounted near the microphone. The desk-mate station, when ordered for remote control, includes a desk-mount speaker (control panel of desk-mate cabinet replaced by grille). Connect external speaker between terminals 9 and 10 of terminal board TB501 on the Receiver Power Supply chassis. The speaker may be turned down in an unattended station by means of its volume control. If the speaker is disconnected, however, a 3.5-ohm, 4-watt resistor must be substituted across terminals 9 and 10 of terminal board TB501.

The key link in any Remote Control installation is the telephone line from the Remote Control or Dispatch Unit to the Remote Control Panel. In order to obtain the most satisfactory service over this link, some general knowledge of line capabilities and control methods is essential. A brief description of Telephone Line characteristics and Control Methods is contained in both the Remote Dispatch or Control Unit and Remote Control Panel instructions, shipped separately with the equipment.

1. There are three methods of control: Connect the telephone line/s for the desired method, as instructed below:

a) Use two telephone pair: one for audio and one for control. For this method, connect control pair between TB701-5 and TB701-6 and connect audio pair between TB701-1 and TB701-2. Connect jumper between TB701-3 and TB701-4.

b) Use one metallic pair for both audio and control, simplexing the control voltage from the center tap of the output transformer to earth ground. For this method, jumper TB701-3 to TB701-4 to TB701-5, and TB701-6 to TB701-8. Connect telephone pair between TB701-1 and TB701-2.

c) Use one metallic pair for both audio and control, simplexing the control voltage from one line to the other by splitting the output transformer with a capacitor. For this method, jumper TB701-3 to TB701-5 and TB701-4 to TB701-6. Connect telephone pair between TB701-1 and TB701-2. Remove jumper between TB701-8 and TB701-9.

2. Connect a good earth ground to TB701-8.

LOCAL/REMOTE CONTROL

Remote Station

Instructions for connecting the Remote Control Unit to the telephone line/s are included in the separate instruction book for the Control Unit.

Base Station

1. Connect the Remote Control Panel to the telephone line/s, as shown in the Remote Control section above. The Remote Control Panel is mounted in the Desk-Mate cabinet, and is connected to the Transmitter and Receiver through a Remote Overlay Harness.

2. Connect the microphone to the jack on the Desk-Mate control panel.

3. Adjust the telephone line to the proper level by setting

the volume control, located on the Receiver Power Supply (refer to the Installation Instructions for the Remote Control Unit). The speaker "L" pad can then be adjusted without affecting the line level. The speaker and its "L" pad are mounted on the Desk-Mate control panel.

RELAY STATION CONTROL

Additional instructions covering Radio Relay operation are shipped with relay stations.

Mount the microphone at a convenient location inside the cabinet or on the side of the Desk-Mate or floor-mount cabinet. Connect the microphone to jack J509 on the Transmitter Power Supply chassis.

The desk-mate, floor-mount and pole-mount stations are provided with a speaker to be mounted near the microphone. Connect this speaker between terminals 9 and 10 of terminal board TB501 on the Receiver Power Supply chassis.

BLOWER OPERATION

For continuous duty, the transmitter and the 250-watt Power Amplifier are supplied with blowers. These blowers are installed and connected at the factory, but may be connected by the customer to operate only when the transmitter is keyed rather than continuously. The connections may be changed as follows:

TRANSMITTER BLOWER

As normally supplied, the transmitter blower will operate continuously as long as the power switch is on. If it is desired to have the blower operate only while the transmitter is keyed, remove the jumper between terminals 2 and 3 of terminal board TB503 on the Transmitter Power Supply chassis.

250-WATT POWER AMPLIFIER BLOWER (25-50 MC and 144-179 MC)

The blower on the 250-watt Power Amplifier is also normally supplied for continuous operation. For operation only while the transmitter is keyed, move wire #68 in the cabinet harness from TB481-7 to TB481-6.

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

30ER18 Printed in U.S.A.

ADJUSTMENT, OPERATION AND MAINTENANCE OF 144-174 MC, 50-WATT PROGRESS LINE STATION COMBINATIONS

After the G-E Progress Line Station Combination has been installed and the power, control and antenna connections have been made, there are a few adjustments that need to be made before the station is placed in operation. These adjustments consist primarily of loading the transmitter, zeroing the discriminator of the receiver and setting the receiver SQUELCH and VOLUME controls.

Power is applied to the station combination by means of the power switch on the rack-mounted control panel and/or the power switch on the front panel of desk-mate or desk-mount stations. The Transmitter and Receiver Power Supplies are also provided with switches which must be closed to apply power to each unit.

ADJUSTMENT

While making the adjustments on the pole-mount, desk-mate or desk-mount station, an external meter will be required. The voltage indications given in the following adjustment procedure are the approximate values that should be observed when using a 20,000 ohm-per-volt meter which covers the range of 0-3 volts. All meter readings are taken between the jack indicated and the GND jack on the power supply chassis.

Two meters are provided above the front door of the floor-mount stations for tuning the transmitter and the receiver. The metering jacks on the transmitter and the receiver are shunted within the unit, so that these two meters will be sufficient for all normal tuning needs. By using the polarity-reversing switch on each meter, the single meter lead from each meter is used for metering both positive and negative voltages. Note that the two positions of the polarity-reversing switch are labeled "GRN-" and "RED+". By setting the switch for the color of the metering jack into which the meter lead is to be plugged, the meter will be deflected up scale. Since the voltage reading may be either positive or negative at the orange DISC jack, depending upon alignment, the position of the switch may have to be reversed after the meter lead is plugged into the jack.

The following test equipment is required for the adjustment of both transmitter and receiver:

1. A tuning tool and a screwdriver.

2. A 20,000 ohm-per-volt voltmeter which covers the 0-3 volt range, such as G-E Test Set Type EX-1-C or G-E shock-Resistant Test Meter Type EX-2-B.

3. A signal source operating at the system frequency (preferably the transmitter which will normally be monitored by the receiver).

TRANSMITTER ADJUSTMENT

The transmitter was tuned and adjusted to the specified operating frequency before shipment from the factory and should, therefore, require no further adjustment other than loading the power amplifier and matching the transmitter to the antenna. Should realignment or modulation adjustment later become necessary, refer to the TRANSMITTER BENCH ALIGNMENT PROCEDURE (see Table of Contents). Recording the transmitter meter readings during the adjustment will greatly facilitate maintenance work on the unit.

Procedure

1. Connect the antenna or some other suitable 50-ohm load to the ANT jack (J512).

2. Be sure that the Channel A crystal and the Channel B crystal (if used) are connected between pins 4 and 6 and between pins 2 and 8 of crystal socket XY101, respectively.

3. Place the TUNE-OPERATE switch in the TUNE position.

4. Rotate the ANT COUPLING control to its extreme clockwise position.

5. Turn the power on and allow 30 seconds for warmup.

6. Plug the TRANSMITTER meter lead into the CATH PA jack (red-positive).

7. Key the transmitter and tune the PA PLATE control for minimum (dip).

8. Place the TUNE-OPERATE switch in the OPERATE position and dip the MULT-4 PLATE control.

9. Key the transmitter and tune the PA PLATE and ANT TUNING controls alternately until a lower meter reading cannot be obtained.

10. Key the transmitter and tune the ANT TUNING control for maximum CATH PA current. If no peak is observed, rotate the ANT COUPLING control slightly counterclockwise (5° or 10°) and peak the ANT TUNING control. Do not overcouple or a false tuning will be obtained.

11. Key the transmitter and rotate the ANT COUPLING control counterclockwise for a meter reading of 1.4 volts.

12. Key the transmitter and repeak the ANT TUNING control.

13. Key the transmitter and adjust the ANT COUPLING control for a meter reading of 1.5 volts at the CATH PA jack.

14. With the meter lead connected at the PA GRID jack (green-negative), retune the MULT-4 PLATE control for maximum meter reading.

15. Plug the meter into the CATH PA jack and alternately repeat Steps 12 and 13 until no further change in meter reading is obtained.

RECEIVER ADJUSTMENT

The receiver has been factory tuned for optimum performance at the specified operating frequency and should require only tuning the antenna transformer and zeroing the discriminator.

Procedure

1. Be sure that a crystal of the proper frequency is in the high-frequency oscillator crystal socket.

2. Turn on the power and allow 2 or 3 minutes for warmup.

3. Plug the meter lead into the LIM-1 jack (green-negative).

4. While receiving a weak, unmodulated signal (LIM-1 reading below limiting) on the system frequency (exact frequency of transmitter to be monitored), peak the Antenna Transformer (T301 or T322) preselector circuit trimmers C1 (on top of the transformer) and C3 (on bottom of the transformer).

5. Move the meter lead to the DISC jack (orange).

6. While receiving a strong, unmodulated signal on the system frequency (exact frequency of transmitter to be monitored), note the meter reading. If the discriminator meter reads more than ± 2 volts and the transmitter is known to be on frequency, adjust the OSC-1 trimmer (f_A) for zero discriminator reading.

7. After the receiver has had at least 5 minutes to warm-up, measure and record the LIM-1 noise current with the antenna both connected and disconnected. It is also important to observe the supply voltage, since the LIM-1 noise current varies directly with the supply voltage. Recording the LIM-1 noise current will greatly facilitate future maintenance work on the receiver.

8. Rotate the SQUELCH control (on the front control panel of desk-mate or desk-mount stations or on the Receiver Power Supply chassis of floor-mount or pole-mount stations) clockwise until noise is heard in the loudspeaker and then counterclockwise until the noise just disappears. For general use, turn the control approximately 15° beyond the point at which the receiver quiets. (On desk-mate and desk-mount stations, it will be necessary to preset the SQUELCH control on the Receiver Power Supply Panel fully counterclockwise before performing this step.)

9. To adjust volume control, rotate the speaker L-pad to its extreme clockwise position. While monitoring a modulated signal, adjust the VOLUME control on the Receiver Power Supply chassis for the highest listening level which will ever be desired. To avoid unnecessary distortion, set the control as low as possible. Reset the speaker L-pad for the normal listening level.

OPERATION

Apply power to the station combination by placing the ON-OFF switch on the rack-mounted control panel and/or the power switch on the front panel of locally controlled desk-mate and desk-mount stations in the ON position. Be sure that the power switches on the transmitter and receiver are also on. The green POWER ON light on the desk-mate, desk-mount and floor-mount cabinets should be illuminated and calls will be heard in the speaker.

Connect the controlled-reluctance microphone to jack J509 on the Transmitter Power Supply Chassis or J901 on locally controlled desk-mate control panel. If a remote control panel is being used which has been equipped for intercom use, use a carbon microphone plugged into the jack on the remote control panel. To key the transmitter, press the microphone button. The red TRANSMIT pilot

lamp on the control panel of the locally controlled desk-mate or desk-mount station or on the meter panel of the floor-mount station will light when the transmitter is keyed.

MICROPHONE TECHNIQUE

Misuse of the microphone is probably the greatest single reason for "poor transmitter performance". It is to the operator's advantage, therefore, to try a few calls and, through practice and constructive criticism at the receiving end, develop a microphone technique that is best suited to his characteristics of speech. If the operator holds the microphone within three inches of his lips and talks at a normal speaking level, directly into the microphone, the message can be easily understood and background noise will be kept at a minimum.

For persons having voice levels below the average, or for speaking at average levels up to 4 inches from the microphone, replace the 12AU7 (V110) audio amplifier tube (not the limiter) in the transmitter with a 12AT7. This will provide 12 db of gain. For speaking up to 6 inches from the microphone, replace the 12AU7 (V110) tube with a 12AX7. The gain with the 12AX7 will be 15 db.

If more audio is required, use a 12AX7 audio amplifier and bypass the cathode of the second audio amplifier stage (XV110-3) of the transmitter with a 10-microfarad, 25-volt capacitor. This provides about 23 db of gain and permits speaking from 10 to 14 inches from the microphone.

INTERCOM

If Remote Control Panel KC-7-B has been modified by the Intercom Kit, a serviceman at the transmitter may hold a conversation with the dispatcher over the telephone lines for testing purposes by placing the INTERCOM-DISPATCH switch in the INTERCOM position. Since the intercom signal is at a low level, the dispatcher will have to readjust his volume control. Be sure to return the INTERCOM-DISPATCH switch to DISPATCH after completing the conversation. Additional instructions for the operation of the Remote Control Panel are included in the separate instructions shipped for the panel. With the switch in the DISPATCH position, local testing of the Station Combination may be done by keying the microphone.

REMOTE AND REPEATER CONTROL

Additional operating instructions are shipped in a separate instruction book for remote and relay stations.

MAINTENANCE

PREVENTIVE MAINTENANCE

To obtain optimum performance from the equipment and to correct mechanical and electrical failures before they interrupt proper operation of the system, a program of regular preventive maintenance should be followed. This preventive maintenance should include the maintenance checks listed below, but the interval between checks will usually vary according to local operating conditions, the duty cycle of the station and the availability of maintenance personnel.

MAINTENANCE CHECK	INTERVAL BETWEEN CHECKS		
	Every 2 Months	Every 6 Months	As Required
Input Voltage - Check input voltage across terminals 1 and 2 of TB704. Meter should read within 10% of 117 volts a-c.	X		
Filament Voltage - Check for 6.3 volts a-c ± 10% at TB501-11 on Receiver Power Supply and at TB502-8 on Transmitter Power Supply.	X		
B+ Voltages - Check following voltages: LV-B+(multiply by 100)-200 volts ± 10% HV-B+(multiply by 200)-420 volts ± 10% REC B+(multiply by 100)-200 volts ± 10%	X		
Transmitter Alignment - Compare meter readings at transmitter multiplier metering jacks with voltages read during initial tune up. Touch-up multiplier tuning. Test any tubes suspected of low emission. Retune transmitter PA. (See Simplified Alignment Procedure on transmitter SERVICE OUTLINE.)	X		
Receiver - Receiver LIM-2 voltage on noise should be at least 0.75 volt (measured on 20,000 ohm-per-volt voltmeter). OSC-1 voltage should be at least 1.2 volts. While receiving an unmodulated signal on the station frequency, adjust OSC-1 trimmer (f_A) for zero discriminator reading. (See receiver maintenance section.) Test any tubes suspected of low emission.	X		

Relay Contacts - Examine relay contacts. Burnish pitted contacts and coated contacts to smooth out metallic deposits or to remove the coating. (See detailed maintenance instructions in instructions for Transmitter Power Supply.)	X		
Transmission Line - Check for positive indication of pressure on transmission line pressure gauge (if pressurized line is used).	X		
Antenna - Check antenna and mast for mechanical stability.		X	
Blower - (If used, see detailed maintenance instructions in instructions for Transmitter Power Supply.) 1 - Clean dust from impeller blades of blower. 2 - Lubricate blower - If operating continuously If operating intermittently	 X	 X X	
Emergency Power Plant - If station has emergency power plant, run generator for 15 minutes, check fuel and check emergency power alarm circuit.	X		
Mechanical Inspection - Visually check cables, plugs, sockets, terminal boards and components for good electrical connections. Check tightness of nuts, bolts and screws to make sure that nothing is working loose from its mounting.		X	
Cleaning - Remove, with a vacuum hose, dust which has accumulated inside the cabinet.		X	
Frequency Check - Check transmitter frequency and deviation as required by FCC. Check for voltage reading of 1.5 volts at CATH PA jack when transmitter is keyed.			X

CORRECTIVE MAINTENANCE

As much useful service information as possible has been provided on the SERVICE OUTLINE and the ELEMENTARY DIAGRAM for each unit. Once a serviceman has localized his trouble in a certain unit, he should refer to the two service diagrams for that unit. The SERVICE OUTLINE gives voltage and resistance readings, a tuning procedure for the unit, service hints and typical voltage readings at metering jacks. The OUTLINE also shows the location of parts on the chassis. The parts list for the unit is included on the back of its ELEMENTARY DIAGRAM.

Tube replacements will usually correct maintenance problems. Most servicemen have found substitution of a new tube to be the best method of testing a tube. In isolated stations where maintenance is difficult, or in stations where operational failures are expensive, the use of G-E Five-Star tubes, or tubes which have been run for 24 hours under vibration, and the use of a regular preventive maintenance program will often prove economical.

To localize the trouble is of prime importance in trouble-shooting. If tube replacement and a close visual inspection fails to reveal the trouble, refer to the voltage and resistance measurements and other service information given on the SERVICE OUTLINE for the unit.

Resistors used in the station are conservatively rated and should last the life of the unit unless trouble develops elsewhere in such a manner as to burn them out. In the case of intermittent trouble, analyze the effect upon the circuit if certain capacitances were defective. Capacitors will never show "open" unless a lead is broken. Leaks or shorts are more apt to occur.

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

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INSTALLATION DIAGRAM

POLE-MOUNT STATION
CABINET ML-7132483-G1-3

(M-7485209, REV. 1)

20ER22

3,5,6

CABINET BLOWER ASSEMBLY
INSTALLATION AND MAINTENANCE

The Cabinet Blower Assembly (Special) for this regulation is of separately and must be installed in the field.

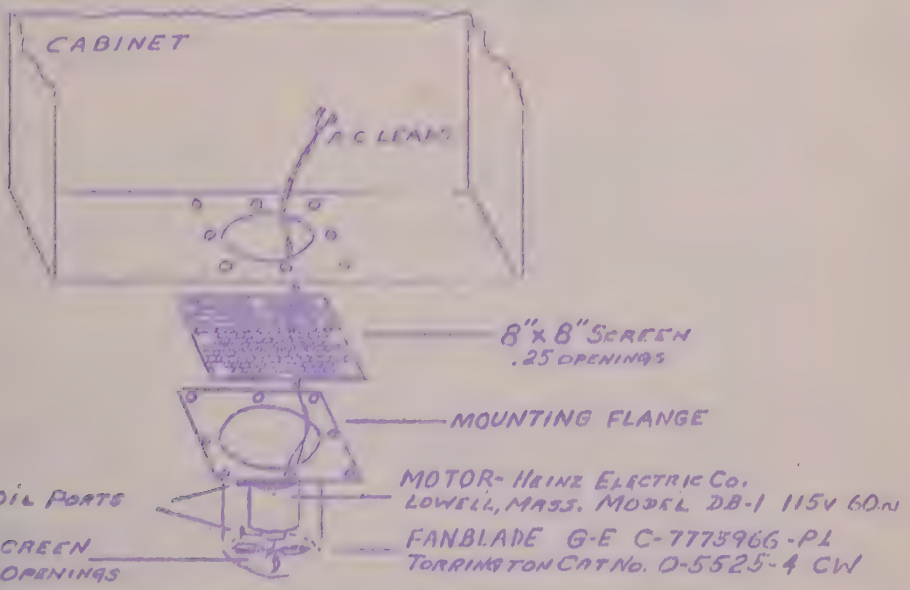
After the Wide Mount Cabinet has been placed into position, install the Blower Assembly, as follows:

1. Remove the eight No. 10 X 5/8 mounting hardware from the Blower Assembly Mounting Flange.

2. Place the Assembly into position on outside, bottom panel of cabinet; place the 1/4-inch screening between the flange and cabinet. Route the a-c supply leads through the main ventilating hole.

3. Insert the No. 10 bolts and fasten with 5/8-inch nuts on inside of cabinet.

4. Connect the lugged a-c supply leads to matching leads from the Speaker Mounting Panel.



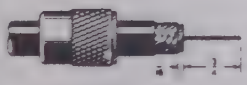
A. Whenever the Station Combination is serviced, make sure the lower filter screen is free of foreign matter.

B. Two or three drops of motor lubricant should be placed in the oil ports at least twice per year. The ports may be reached through openings in the upper screen, using an oiler spout .22 inches in diameter X 4 inches in length.

FOR ASSEMBLY OF 83 SERIES, TYPE UHF PLUGS

ASSEMBLY OF CABLES TO 83-1SP PLUG

Cut end of cable even.
Remove vinyl jacket 1⅛"—*don't nick braid.*



Bare ¾" of center conductor—*don't nick conductor.*
Trim braided shield 1/16" and trim.
Slide coupling ring on cable.

Screw the plug assembly on cable.
Solder assembly to braid thru solder holes.
Solder conductor to contact sleeve.

Screw coupling ring on assembly.

ASSEMBLY OF CABLES TO 83-1SPN PLUG

Cut end of cable even.
Remove vinyl jacket 1⅛"
don't nick braid.

Bare ¾" of center conductor
—*don't nick conductor.*
Trim braided shield 1/16"
and tin.
Slide back shell and coupling ring on cable.

Screw the plug assembly on cable
Solder plug assembly to braid thru solder holes
Solder conductor to contact sleeve.

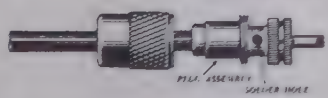
Position coupling ring and back shell
Tighten set screw

ASSEMBLY OF CABLES TO 83-1SP PLUG USING ADAPTERS 83-168 AND 83-185

Cut end of cable even.
Remove vinyl jacket 21/32"
—*don't nick braid.*
Slide coupling ring and adapter on cable.

Fan braid slightly and fold back over cable

Compress braid around cable.
Position adapter to dimension shown.
Press braid down over body of adapter and trim.
Bare ½" of center conductor
—*don't nick conductor.*
Pre-tin exposed center conductor.



Screw the plug assembly on adapter.
Solder braid to shell thru solder holes.
Solder conductor to contact sleeve.

Screw coupling ring on back shell.

ASSEMBLY OF TWINAX TO 83-22SP PLUG

Plugs 83-2SP and 83-21SP are assembled as shown except remove vinyl jacket 1¼".

Cut end of cable even
Remove vinyl jacket 1⅛"
—*don't nick braid.*

Bare ¾" of conductors
don't nick conductors
Trim braided shield 1/16"
and tin

Slide coupling ring on cable
Screw back shell on cable
see that solder hole lines up with conductor as shown

Assemble front shell to back shell
If assembled properly, the solder holes in both front shell and back shell will line up

Solder braid to shells thru solder holes.
Solder conductors to contact sleeves

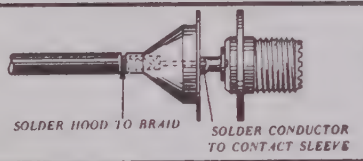
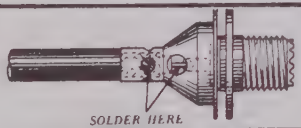
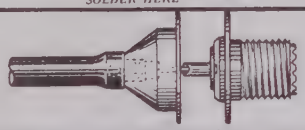
Screw coupling ring on back shell

Installation Diagram

UHF AND BNC CONNECTORS AND ADAPTERS

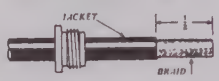
(A-7135401, Rev. 0)

ASSEMBLY OF 83 SERIES, UHF RECEPTACLES USING HOODS

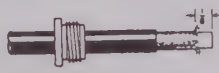
		83-76S	83-1H	83-1HP	83-2H
	Cut end of cable even. Remove vinyl jacket. *Do not nick braid.*	3/4"	5/8"	3/4"	3/4"
	Remove braid and dielectric to expose center conductor. . . . . *Do not nick conductor.*	5/16"	5/16"	5/16"	5/16"
	Fan braided shielding.				
	Smooth out shielding. Trim braid to size. . . . . Tin braid and wipe clean. Soldering and assembly depends on the hood used, as illustrated.	3/8"	3/16	3/8"	3/16
	Slide hood over braid. Solder conductor to contact. Slide hood flush against receptacle and bolt both to chassis. Solder hood to braid as illustrated. . . . . Tape this junction if necessary.	Yes	No	No	No
	Slide hood over braid. Bring receptacle flush against hood. Solder hood to braid and conductor to contact sleeve thru solder holes as illustrated. . . . . Tape junction if necessary.	No	No	Yes	No
	Slide hood over braid and force under vinyl. Place inner conductor in contact sleeve and solder. Push hood flush against receptacle. Solder hood to braid through solder holes. . . . . Tape junction if necessary.	No	Yes	No	Yes

ASSEMBLY INSTRUCTIONS FOR TYPE BNC CONNECTORS

Cut end of cable even.



Remove vinyl jacket ½" — *don't nick braid.*



Push braid back, and remove ⅛" of insulation and conductor.

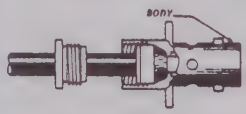
Taper braid.

Slide sleeve over tapered braid. Fit inner shoulder of sleeve squarely against end of jacket.

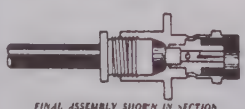
With sleeve in place, comb out braid, fold back smooth as shown, and trim 3/32"

Bare center conductor ⅛" — *don't nick conductor.*

Tin center conductor of cable. Slip female contact in place and solder. Remove excess solder. *Be sure cable dielectric is not heated excessively and swollen so as to prevent dielectric entering body.*



Push into body as far as it will go. Slide nut into body and screw into place, with wrench, until moderately tight. Hold cable and shell rigidly and rotate nut.



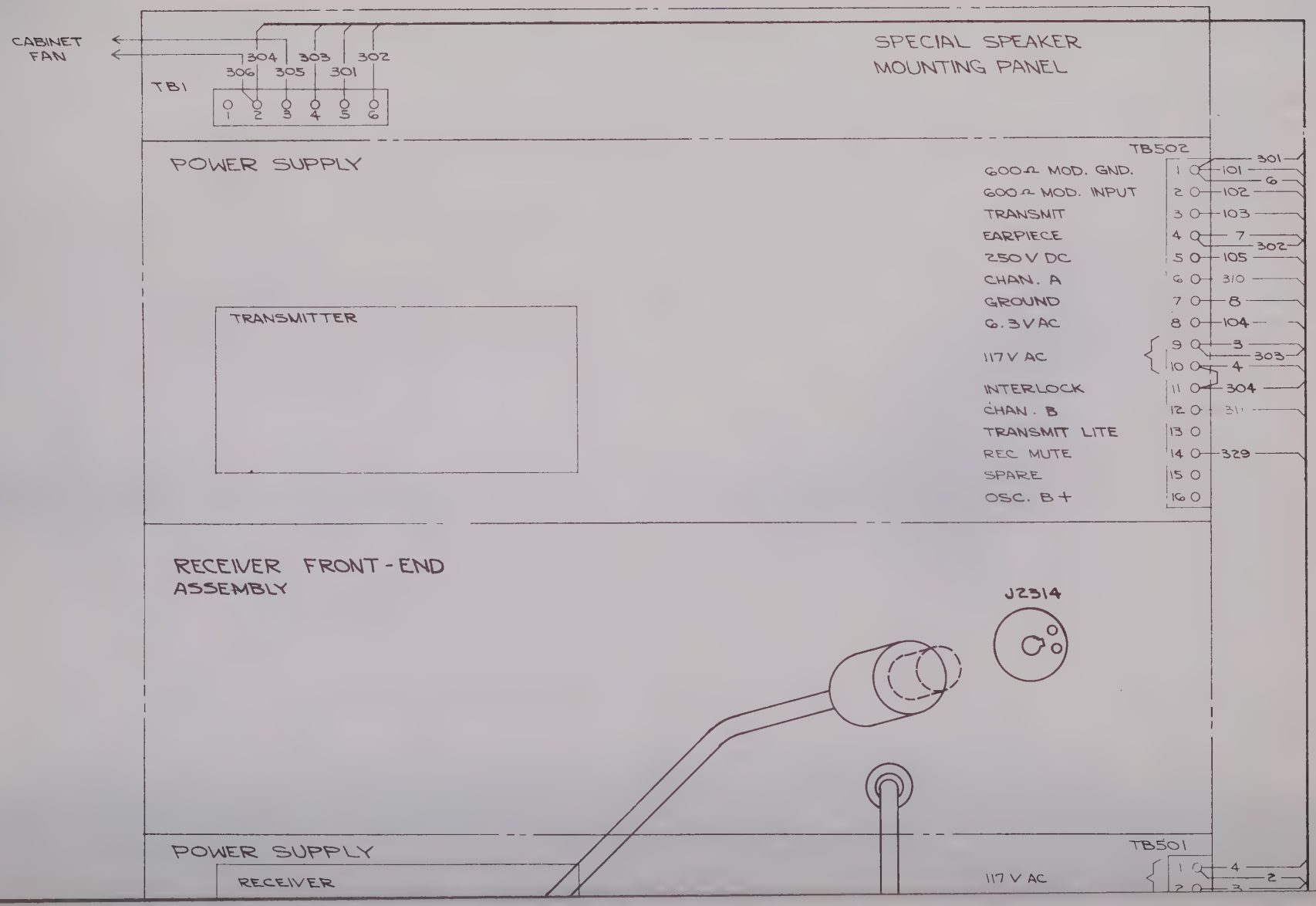
This assembly procedure applies to BNC jacks. The assembly for plugs is the same except for the use of male contacts and a plug body.

FINAL ASSEMBLY SHOWN IN SECTION

Installation Diagram

UHF AND BNC CONNECTORS
AND ADAPTERS

(A-7135402, Rev. 0)


CABINET FAN
304
303
302
306
305
301
TB1
1
2
3
4
5
6
SPECIAL SPEAKER MOUNTING PANEL
POWER SUPPLY
TRANSMITTER
TB502
600Ω MOD. GND.
600Ω MOD. INPUT
TRANSMIT
EARPIECE
250 V DC
CHAN. A
GROUND
6.3 V AC
117 V AC
INTERLOCK
CHAN. B
TRANSMIT LITE
REC MUTE
SPARE
OSC. B+
301
101
6
102
103
7
302
105
310
8
104
3
303
4
304
311
329
RECEIVER FRONT-END ASSEMBLY
J2314
POWER SUPPLY
RECEIVER
117 V AC
TB501
4
2
3

Interconnection Diagram

PO36ER6 STATION COMLINATION SPECIAL

(D-5498794, Rev. 0)

PRODUCTION CHANGE SHEET
FOR
TRANSMITTER MODELS 4ET21A1 & 11, REV. R
TRANSMITTER MODELS 4ET21A2 & 12, REV. T

Changes listed below are identified by the letter appearing in the REV. pad.

REV. A (Models 4ET21A2 and 12 only)

Part Changed	Was	Changed To
C135	Added.	Ceramic, 4.0 mmfd ± 0.5 mmfd, 500 v d-c w. P-7770468-P4.
L105	Coil: 3/4 at 8 turns per inch 0.637" ID, of B11B10A5, 0.060" dia. A-7145857-P1.	Coil: 1-3/4 turns at 16 turns per inch 0.625 ID of Formex B22F1, 0.641" dia. A-7145857-P1.
L113	Loop: made of B11B10A5, 0.080" dia tinned copper wire. A-7145622-P1.	Loop: made of B11B10A5, 0.080" dia tinned copper wire changing length and configuration of loop. A-7145622-P1.
R102	Added.	Composition, 470 ohms ± 10%, 1/2 w. C-3R77-P471K.
R116	Composition, 0.10 megohm ± 10%, 1/2 w. C-3R77-P104K.	Replaced by R117.
R117	Added in place of R116.	Composition, 27,000 ohms ± 10%, 1/2 w. C-3R77-P273K.
R185	Composition, 0.18 megohm ± 10%, 1/2 w. C-3R77-P184K.	Replaced by R188.

Part Changed	Was	Changed To
R188	Added in place of R185.	Composition, .10 megohm ± 10%, 1/2 w. C-3R77-P104K.
R202	Added.	Composition, 470 ohms ± 10%, 1/2 w. C-3R77-P471K.

Text Change

EBI-41059 - Pg. 4 - 1st sentence, 1st paragraph under multipliers - change R116 reference to R117.

Schematic Change

C135 - Add between XV105-5 and ground.
R102 - Add in series with XV101-1 (grid) between junction R101-C101 and XV101-1.
R116 - Delete symbol reference and value.
R117 - Add reference and value in place of former R116.
R185 - Delete symbol reference and value.
R188 - Add symbol reference and value in place of former R185.
R202 - Add in series with XV201-1 (grid) between junction R201, C201, and XV201-1.

REV. B (Models 4ET21A2 and 12 only)

Part Changed	Was	Changed To
C128	Added.	Ceramic, temp compensating tube type 4.0 mmfd ± 10%, 500 v d-c w. P-7770468-P4.
C205	Added to 4ET21A12.	Ceramic, high K disk, 0.0015 mfd +100% -0%, 500 v d-c w. C-7774750-P5.
L103	RF Choke: inductance 50 uh ± 10%, max current 50 ma, resistance 4.0 ohms. National Type R-33. K-7127925-P3.	Replaced by R102.

Part Changed	Was	Changed To
L203	RF Choke: inductance 50 uh ± 10%, max current 50 ma, resistance 4.0 ohms. National Type R-33. (Two Freq. use only.)	Replaced by R202.
R102	Wired between R101, XY101-4 junction and XV101-1.	Replaces L103.
R202	Wired between R201, XY101-2 junction and XV201-1.	Replaces L203.

Text Change

None.

Schematic Change

C128 - Add symbol, reference and value from XV104-6 to XV104-C (ground).

C205 - Add symbol, reference and value from XV201-6 to XV201-G3 (ground).

L103 - Remove symbol and reference and replace by symbol, reference and value of R102.

L203 - Remove symbol and reference and replace by symbol, reference and value of R202.

R102 - Replace by direct short between R101, XY101-4 junction and XV101-1 and remove reference.

R202 - Replace by direct short between R201, XY101-2 junction and XV201-1.

REV. C (Models 4ET21A2 and 12 only)
REV. A (Models 4ET21A1 and 11 only)

Part Changed	Was	Changed To
C141	Added.	Ceramic, high K disk, 0.0015 mfd +100% -0%, 500 v d-c w. C-7774750-P5.

Text Change

None.

Schematic Change

C141 - Model 4ET21A1,11 - Add symbol, reference and value from junction of R144 and R138 to ground.
- Model 4ET21A2,12 - Add symbol, reference and value from junction of R144 and R142.

REV. B (Models 4ET21A1 and 11 only)
REV. D (Models 4ET21A2 and 12 only)

Part Changed	Was	Changed To
L101	RF Choke: inductance 50 uh ± 10%, max current 50 ma, resistance 4.0 ohms. National Type R-33. G-E Dwg. K-7127925-P3.	Replaced by L108.
L108	Added in place of L101.	RF Choke: inductance 39 uh ± 10%. Jeffers Cat. #10203-40. G-E Dwg. B-7488079-P50.

Text Changes

Change references from L101 to L108.

Elementary Diagram Changes

Change L101 to L108.

REV. C (Models 4ET21A1 and 11 only)
REV. E (Models 4ET21A2 and 12 only)

Part Changed	Was	Changed To
R188	Resistor: composition, 0.10 megohm ± 10%, 1/2 w. G-E Dwg. C-3R77-P104K.	Replaced by R191.
R191	Added in place of R188.	Resistor: composition, 68,000 ohms ± 10%, 1/2 w. G-E Dwg. C-3R77-P683K.

Elementary Diagram Change

R188 (100K) was changed to R191 (68K).

Text Change

None.

REV. D (Models 4ET21A1 and 11 only)
REV. F (Models 4ET21A2 and 12 only)

Part Changed	Was	Changed To
C153	Capacitor: variable, air, 2.53 to 12.78 mmfd, 1250 v d-c peak, Johnson Cat. #160-170-43.	Replaced by C167.
C167	Added in place of C153.	Capacitor: variable air, 3.2 to 12 mmfd, 1400 v d-c peak. Teleradio Cat. #T-9476.
L114	Coil: 2 turns at 11 per inch. 0.687" ID of B22F1, #14 AWG, 0.064" dia. G-E Dwg. and Part No. A-7144943-P1.	Replaced by L116.
L116	Added in place of L114.	Coil: 1 turn at 11 turns per inch. 0.687" ID of 0.064" dia, #14 AWG B22F1. G-E Dwg. and Part No. A-7144943-P2.

Text Changes

References to C153 were changed to C167.

Elementary Diagram Changes

"C153, 2.53-12.78" was changed to "C167, 3.2-12" and "L114" was changed to "L116".

REV. E (Models 4ET21A1 and 11 only)
REV. G (Models 4ET21A2 and 12 only)

Part Changed	Was	Changed To
C102	Capacitor: ceramic, temperature compensating, tubular; 47 mmfd ± 10%, 500 v d-c w. G-E Part No. P-7770468-P17.	Replaced by C106.
C106	Added in place of C102.	Capacitor: ceramic, temperature compensating disk; 100 mmfd ± 10%, 500 v d-c w. G-E Part No. C-7774846-P21.
C202	Capacitor: ceramic, temperature compensating tubular, 47 mmfd ± 10%, 500 v d-c w. G-E Part No. 7770468-P17.	Replaced by C206.
C206	Added in place of C202.	Capacitor: ceramic, temperature compensating disk; 100 mmfd ± 10%, 500 v d-c w. G-E Part No. C-7774846-P21.

Text Changes

C102 was changed to C106.
C202 was changed to C206.

Elementary Diagram Changes

C102, #47 was changed to C106, #100.
C202, #47 was changed to C206, #100.

REV. F (Models 4ET21A1 and 11 only)
REV. H (Models 4ET21A2 and 12 only)

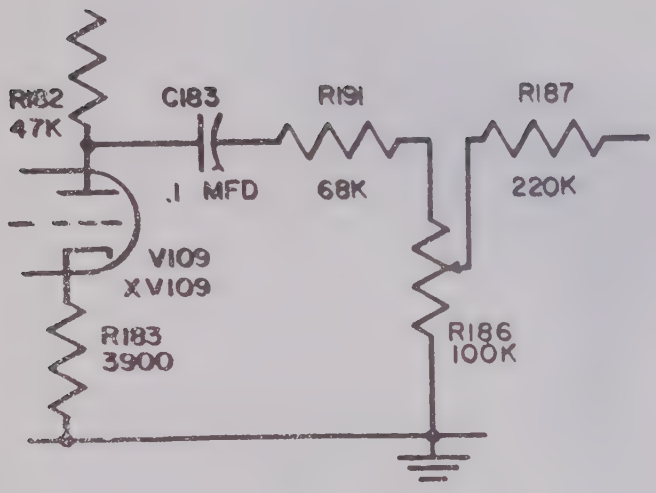
Part Changed	Was	Changed To
C188 thru C190	Added.	Capacitor, silver mica: CM 15 case, 180 mmfd ± 10%, 500 v d-c w. Electro Motive Mfg. Type CM15. G-E Part No. P-3R122-P21.
R191	Resistor, composition: 68,000 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P683K.	Deleted.
R193 thru R195	Added.	Resistor, composition: 27,000 ohms ± 10%, 1/2 w. G-E Part #C-3R77-P273K.
XY101	Crystal socket and ring: mica-filled phenolic, octal. Cinch Cat. #9865. G-E Part No. A-7140823-P2.	Replaced by XY102.
XY102	Added in place of XY101.	Crystal socket and ring: octal, mica-filled yellow and black phenolic with 2 diametrically opposed keyways. Similar to Cinch Cat. #51E16871. G-E Part No. A-7147225-P1.

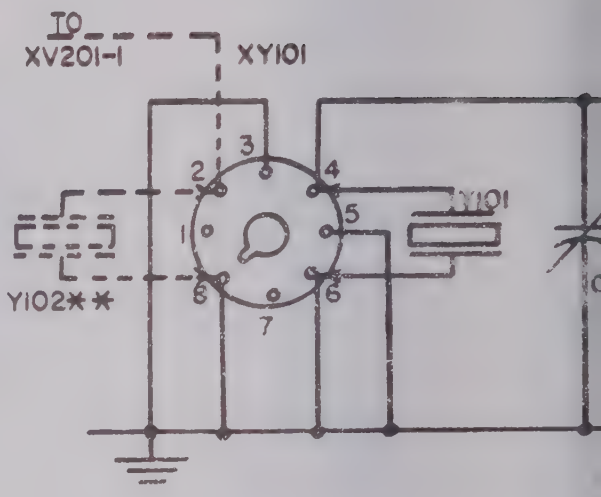
Text and Service Outline Changes

XY101 was changed to XY102.

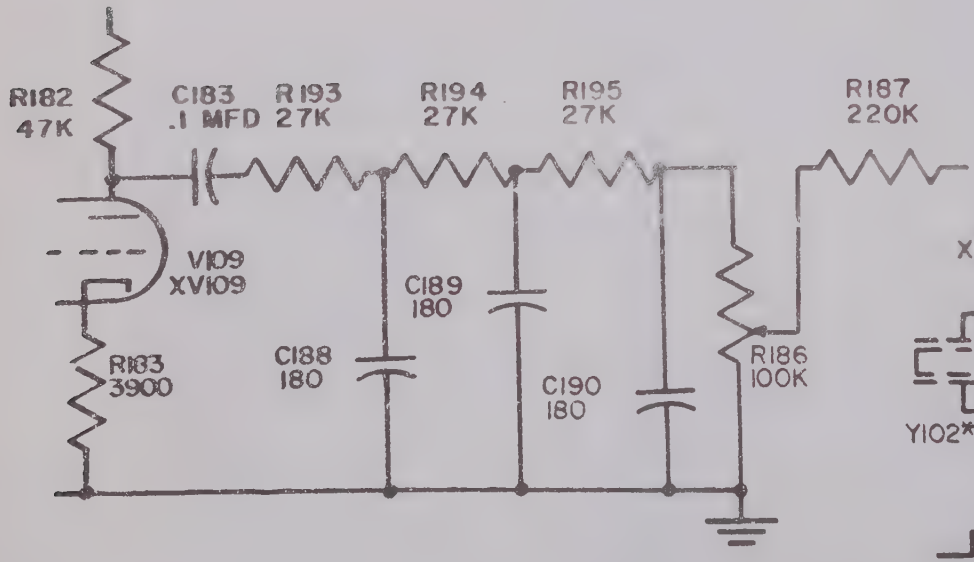
Elementary Diagram Changes

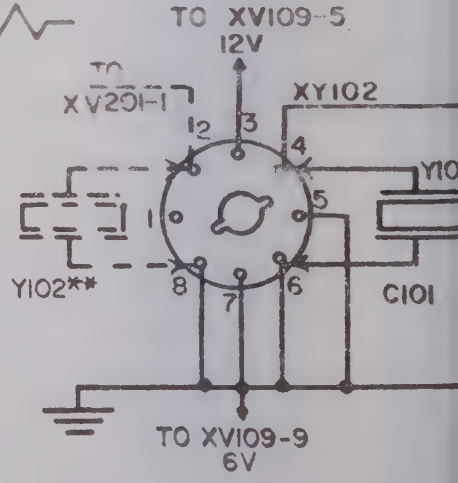
OLD CIRCUIT:





NEW CIRCUIT:





REV. G (Models 4ET21A1 and 11 only)

Part Changed	Was	Changed To
R105	Added.	Resistor, composition: 5600 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P562K.

Elementary Diagram Changes

R105 (5.6 K ohms) was added in parallel with oscillator plate choke L108.

REV. H (Models 4ET21A1 and 11 only)
REV. J (Models 4ET21A2 and 12 only)

Purpose of Change

The construction of the Power Amplifier housing was changed to provide improved ventilation for the PA tubes.

Parts List, Elementary Diagram and Text Changes

None.

REV. J (Models 4ET21A1, and 11 only)
REV. K (Models 4ET21A2, and 12 only)

Part Changed	Was	Changed To
K101	Relay: 5 to 7.5 v d-c nominal coil, pickup less than 4.5 v d-c at 25 C, dropout 2.25 v d-c at 85 C, resistance 20 ohms 8% at 25 C, contacts 1 form B, 1 form C, contact pressure 30 grams min.	Replaced by K102.

Part Changed	Was	Changed To
K102	Added in place of K101.	Relay: nominal coil rating 4 to 7 v d-c, pickup 3.5 v d-c or less at 25 C, dropout 2 v d-c or less at 25 C, resistance 20-ohms 8% at 25 C, 1 form B, 1 form C contact, 30-grams min. pressure.

Text Change

References to K101 changed to read K102.

Elementary Diagram Change

References to K101 changed to read K102.

Service Outline Diagram Change

References to K101 changed to read K102.

REV. K (Models 4ET21A1 and 11 only)
REV. L (Models 4ET21A2 and 12 only)

Purpose of Change

To simplify removal of the PA shield.

Mechanical Change

The hexagonal post under the perforated PA shield was removed and a clip was added to hold down the rear edge of the shield.

REV. L (Models 4ET21A1 and 11 only)
REV. M (Models 4ET21A2 and 12 only)

Purpose of Change

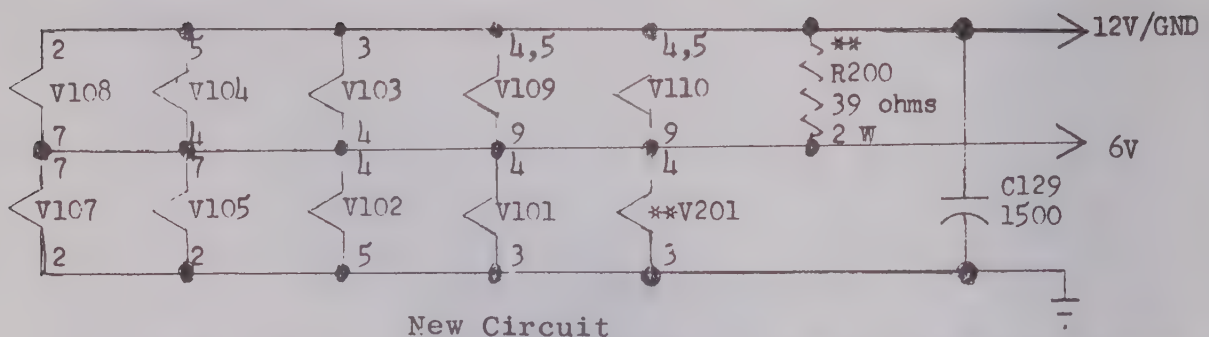
To permit use in Direct Dispatch Systems.

Part Changed	Was	Changed To
C112-B	Capacitor, electrolytic: polarized, twist-prong base, 10-mfd section + 5% -10%, 400 v d-c w. G-E Part No. P-7770994-P19.	10-mfd section of C112 unused.
C129	Capacitor, ceramic Hi-K disk; 0.0015 mfd +100% -0%, 500 v d-c w. G-E Part No. C-7774750-P5.	Deleted.
C136	Added.	Capacitor, ceramic Hi-K disk: 0.0015 mfd +100% -0%, 500 v d-c w. G-E Part No. C-7774750-P5.
R168	Resistor, composition 10,000 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P103K.	Deleted.
V105	Tube: type 2E26.	Replaced by V106.
V106	Added in place of V105.	Tube: type 2E26.
XV105	Tube socket: 8 pin. G-E Part No. K-7133702-G1.	Replaced by XV106.
XV106	Added in place of XV106.	Tube socket: 8 pin G-E Part No. K-7133702-G1.

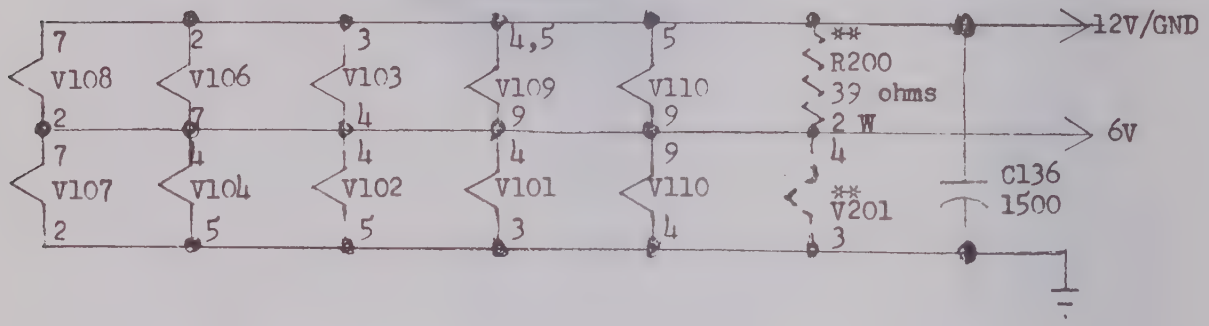
Elementary Diagram Changes

C112-B was deleted. C129 was replaced by C136. R168 was replaced by a direct connection to B+ OSC voltage (P101-11). V105 and XV105 were replaced by V106 and XV106, respectively. On audio amplifier tube V110, pin 1 and pin 6 were interchanged pin 2 and pin 7 were interchanged, and pin 3 and pin 8 were interchanged. The audio B-plus input was moved from the 300-volt supply (MULT B+) to the 200-volt supply (OSC B+). The filament circuit was changed as follows:

Old Circuit



New Circuit



Service Outline Changes

Socket XV110 was rotated 180°. V105 and XV105 were changed to V106 and XV106. The following voltage and resistance readings were changed:

At XV110-8,	1 V	was changed to	3.6 V.
At XV110-6,	42 V	was changed to	85 V.
At XV110-3,	3.6 V	was changed to	1 V.
At XV110-1,	85 V	was changed to	42 V.

At XV110-3, 2200 ohms was changed to 470 ohms.
At XV110-8, 470 ohms was changed to 2200 ohms.

REV. M (Models 4ET21A1 and 11 only)
REV. N (Models 4ET21A2 and 12 only)

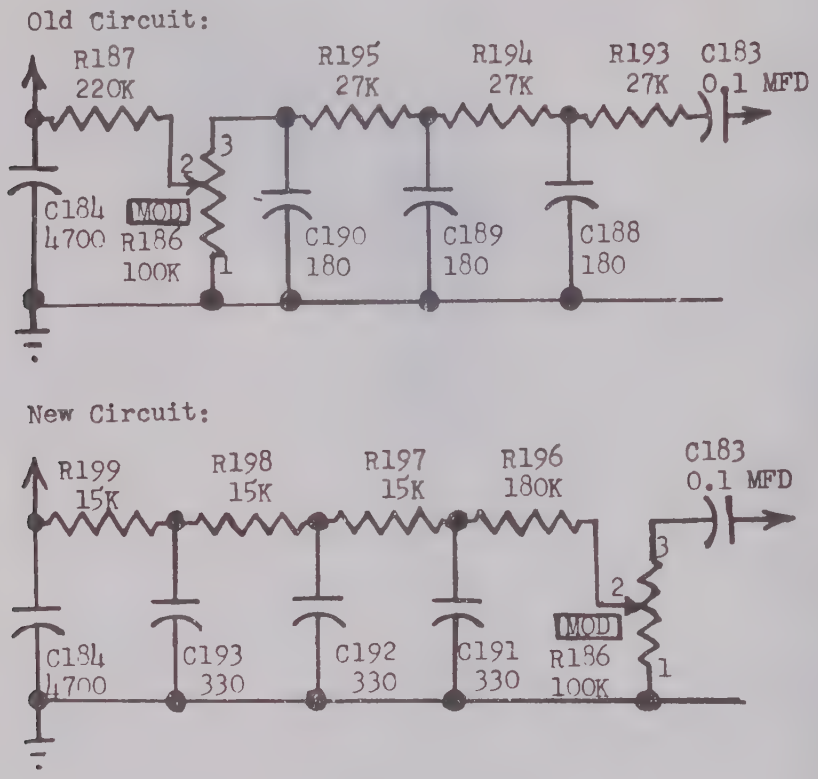
Purpose of Change

To decrease power input to PA driver and to increase available audio output voltage from modulation limiter.

Part Changed	Was	Changed To
C188 thru C190	Capacitor, silver mica: 180 mmfd ± 10%, 500 v d-c w. G-E Part No. P-3R122-P21.	Deleted.
C191 thru C193	Added.	Capacitor, silver mica: 330 mmfd ± 5%, 500 v d-c w. G-E Part No. B-7489162-P39.
R136	Added in place of R137.	Resistor, composition: 47,000 ohms ± 10%, 2 w. G-E Part No. C-3R79-P473K.
R137	Resistor, composition: 22,000 ohms ± 10%, 2 w. G-E Part No. C-3R79-P223K.	Replaced by R136.
R187	Resistor, composition: 0.22 megohm ± 10%, 1/2 w. G-E Part No. C-3R77-P224K.	Deleted.
R193 thru R195	Resistor, composition: 27,000 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P273K.	Deleted.
R196	Added.	Resistor, composition: 0.18 megohm ± 10%, 1/2 w. G-E Part No. C-3R77-P184K.
R197 thru R199	Added.	Resistor, composition: 15,000 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P153K.

Elementary Diagram Changes

Resistor R137 (22K, 2W) was changed to R136 (47K, 2W). The post-limiter filter was changed as follows:



REV. N (Models 4ET21A1 and 11 only)
REV. P (Models 4ET21A2 and 12 only)

Purpose of Change

To provide more effective filtering for heater of crystal oven.

Part Changed	Was	Changed To
R136	Resistor; composition, 47,000 ohms ± 10%, 2 w. G-E Part No. C-3R79-P473K.	Deleted.

Part Changed	Was	Changed To
R137	Added.	Resistor; composition, 22,000 ohms ± 10%, 2 w. G-E Part No. C-3R79-P223K.
L127	Added.	R.F. choke; inductance, 100 uh ± 10%. Jeffers Cat. No. 10404-34. G-E Part No. B-7488079-P72.

Text Change

None.

Elementary and Outline Diagram Changes

Changed "R136, 47K, 2w" to read "R137, 22K, 2 w".

Added L127, 100 uh, in series with 12 V. lead to XY102-3.

REV. P (Models 4ET21A1,11 only)
REV. Q (Models 4ET21A2,12 only)

Purpose of Change

To improve .0005% frequency vs temperature stability.

Part Changed	Was	Changed To
C106 and C206	Capacitor: ceramic disk, temp. compensating, insulated, 100 mmfd ± 10%, 500 v d-c w. G-E Dwg. No. C-7774846-P21.	Replaced by C194 and C209 respectively.
C194 and C209	Capacitor: ceramic temp. compensating, 100 mmfd ± 10%, 500 v d-c w. G-E Dwg. No. C-7473485-P30.	Replaces C106 and C206 respectively.

Elementary Diagram Changes

Changed delineation of C106, 100 mmfd to read C194, 100 mmfd.
Changed delineation of C206, 100 mmfd to read C209, 100 mmfd.

REV. Q (Models 4ET21A1,11 only)
REV. R (Models 4ET21A2,12 only)

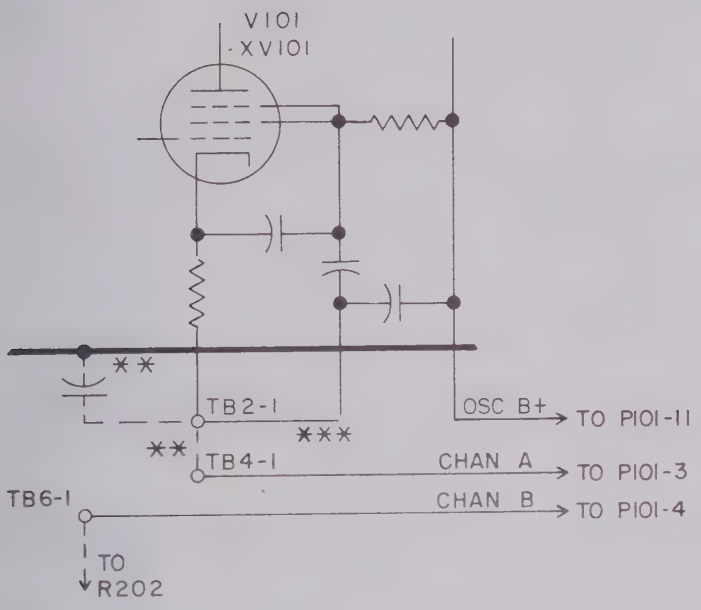
Purpose of Change

To decouple power supply switching transients.

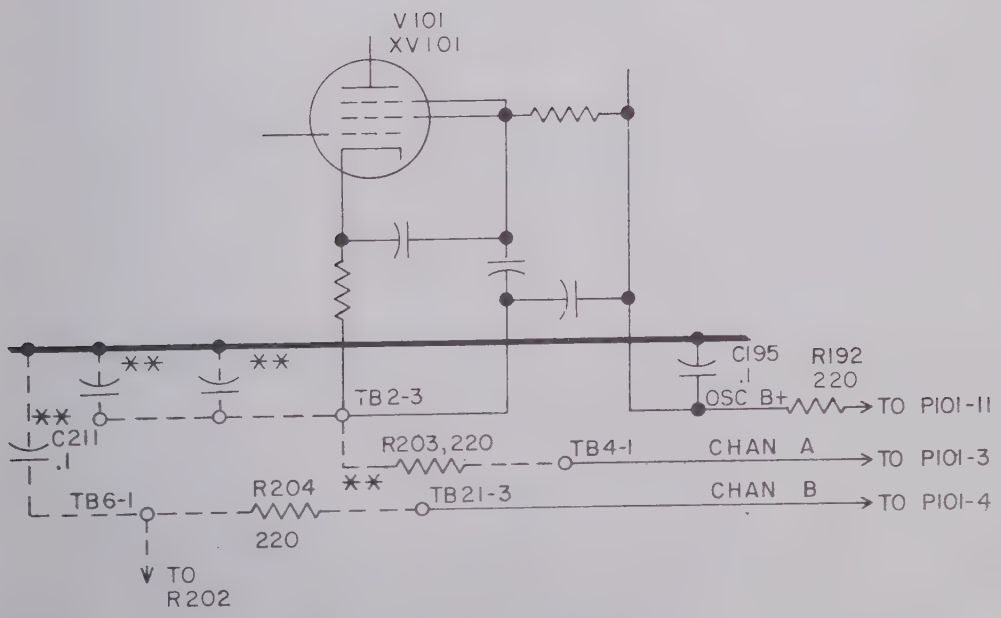
Part Changed	Was	Changed To
R192	Added.	Resistor: composition, 220 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P221K.
C195	Added.	Capacitor; ceramic, Hi-K disk, 0.1 mfd +80% -25%, 500 v d-c w. Sprague Cat. No. 36C190A. G-E Dwg. No. B-7488160-P3.
R203 and R204	Added to Models 4ET20A11, 12 only.	Resistor; composition, 220 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P221K.
C210 and C211	Added to Models 4ET20A11, 12 only.	Capacitor; ceramic, Hi-K disk, insulated, 0.1 mfd +80%-30%, 50 v d-c w. Sprague Cat. #36C172. G-E Dwg. No. A-7161189-P2.

Elementary Diagram Changes

Was:



Changed To:



REV. S (Models 4ET21A2,12 only)

Purpose of Change

To allow transmitter to withstand operation with an open load circuit.

Part Changed	Was	Changed To
C161 C163 C164	Capacitor; ceramic, standoff style, insulated, 22 mmfd ± 5%, 500 v d-c w. Erie Type 323-04. G-E Dwg. No. K-7130608-P3.	Replaced by C196, C198 and C197 respectively.
C196 C197 C198	Capacitor; part of mechanical assembly.	Replaces C161, C164 and C163 respectively.
C162 and C165	Capacitor; ceramic, temp. compensating, tubular, 7.0 mmfd ± 0.5 mmfd, 500 v d-c w. G-E Dwg. No. P-7770468-P7.	Replaced by C207 and C208 respectively.
C207 and C208	Capacitor; ceramic, temp. compensating, tubular, 7.0 mmfd ± 0.5% mmfd, 500 v d-c w. G-E Dwg. No. P-7770468-P7.	Replaces C162 and C165 respectively.
C166	Capacitor; ceramic standoff style, insulated, 7 mmfd ± 5%, 500 v d-c w. Erie Type 323-04, G-E Dwg. No.K-7130608-P2.	Deleted.
L124	Coil; 2 turns at 11-1/2 turns per inch, 0.25-inch ID, of B11B10A5, 0.064-inch dia. G-E Dwg. No. A-7145060-P1.	Replaced by L204.
L204	Coil; 2 turns, right-hand wound. G-E Dwg. No. A-4031598-P1.	Replaces L124.

REV. S (Cont'd)

Part Changed	Was	Changed To
L125	Coil; 3 turns at 8 turns per inch, right-hand wound, 0.38 inches ID, of B11B10A5, 0.064 inch dia. G-E Dwg. No. A-7145062-P1.	Replaced by L205.
L205	Coil; 3 turns, right-hand wound. G-E Dwg. No. A-4031595-P1.	Replaces L125.
L126	Coil; 2 turns at 11-1/2 turns per inch, 0.25-inch ID, of B11B10A5, 0.064 inch Dia. G-E Dwg. No. A-7145060-P1.	Replaced by L206.
L206	Coil; 2 turns, right-hand wound. G-E Dwg. No. A-4031598-P2.	Replaces L126.

Elementary Diagram, Outline Diagram and Text Changes.

Changed delineation of the following:

C161, 22 mmfd to C196.
C163, 22 mmfd to C198.
C164, 22 mmfd to C197.
C162, 7 mmfd to C207, 7 mmfd.
C165, 7 mmfd to C208, 7 mmfd.
L124 to L204.
L125 to L205.
L126 to L206.

Deleted C166.

REV. R (Models 4ET21A1, 11 only)
REV. T (Models 4ET21A2, 12 only)

Part Changed	Was	Changed To
C113	Added.	Capacitor: ceramic, Hi-K disk; 0.0015 mfd +100% -0%, 500 v d-c w. G-E Dwg. No. C-7774750-P5.

Purpose of Change

To provide RF by-pass for crystal oven heater lead in order to minimize any tendency toward frequency change with oven cycling.

Elementary Diagram Change

C113, 1500 MMFD was added between XY102-3 and ground.

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

Printed in U.S.A.

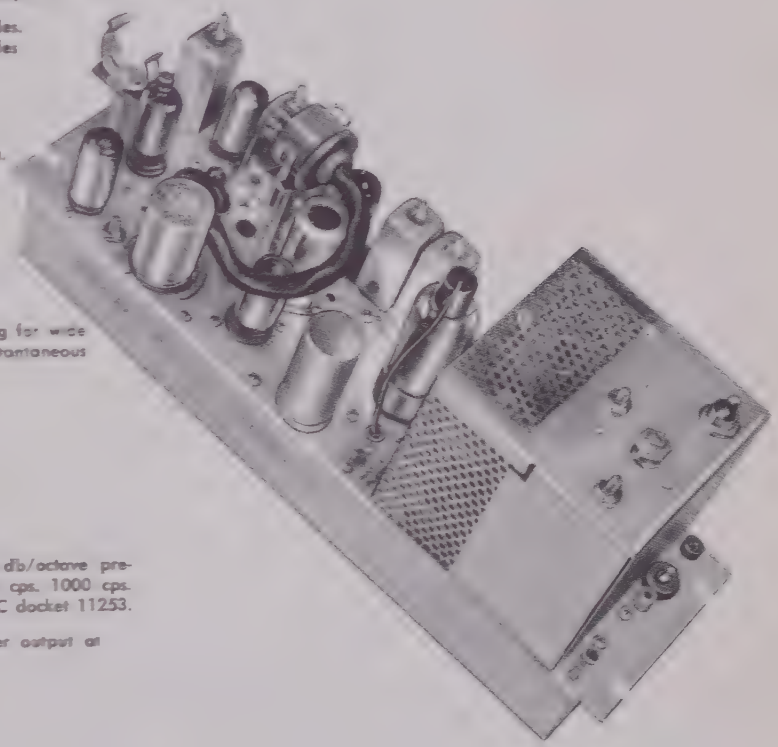
COMMUNICATION EQUIPMENT

SPECIFICATIONS

CHASSIS T-36

OGRESS LINE

e	ET-21-A transmitter for station or mobile service.
C type number	ET-21-A (ET-21-A-5 narrow band).
quency range	Model No. 4ET21A1: 144-152 megacycles. Model No. 4ET21A2: 150.8-174 megacycles.
wer output at rated ut voltage to recommended wer supply	50 watts minimum: 144-162 megacycles. 40 watts minimum: 162-174 megacycles
be complement	6661/6BH6 oscillator. 6678/6U8 modulator (triode section). 1st doubler (pentode section). 6661/6BH6 1st tripler. 6677/6CL6 2nd doubler. 2E26 3rd doubler. 2—6146 final amplifier. 6680/12AU7 audio amplifier. 6680/12AU7 limiter.
odulation	Adjustable from 0 to ±15 kc swing for wide or narrow band operation with instantaneous modulation limiting.
ystal multiplication factor mperature range	24. −30° C to +60° C
equency stability	Heated crystal: ±0.0005%.
udio frequency aracteristics	Within +1 and −3 db of a 6 db/octave pre-emphasis curve from 300 to 3000 cps. 1000 cps. reference. Post limiter filter per FCC docket 11253.
urious and harmonic diation	At least 70 db below rated power output at any frequency.
aximum recommended equency separation in ulti channel operation	0.4% of operating frequency. (Approximately 600 kc)
ze	13½" long x 4" wide x 6" high.
eight	3¾ lbs.



SCOPE OF SPECIFICATIONS—In the construction of the equipment described herein, the full intent of the specification will be met. It is assumed, however, that any departure from the specification, desirable for reasons of improved design or operation, will be permissible.

The equipment described above meets or exceeds all applicable EIA specifications. Technical data is on file with, and the equipment is acceptable for licensing by the FCC.

GENERAL ELECTRIC

OMMUNICATION PRODUCTS DEPARTMENT

LYNCHBURG, VIRGINA

U.S.A.

ECR-239 I 5Y

DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR TRANSMITTER MODELS 4ET20A1, 2, 11 & 12 AND 4ET21A1, 2, 11 & 12

General Electric Transmitter Models 4ET20A1, 2, 11 & 12 and 4ET21A1, 2, 11 & 12 are Progress Line Units designed for operation on fixed frequencies within the 144-174 megacycle band. Both single-frequency and two frequency units are available. Three-frequency and four-frequency operation is possible by using external oscillators. Through the use of plug and cable connections, each transmitter has been made readily interchangeable between mobile and fixed stations. A screwdriver is the only tool needed to make the change. The following chart shows the power output and frequency range of each transmitter model.

	144-152 Megacycles		152-174 Megacycles	
	Single-Freq.	Two-Freq.	Single-Freq.	Two-Freq.
10/25 Watts Nominal Power Output	4ET20A1	4ET20A11	4ET20A2	4ET20A12
50 Watts Nominal Power Output	4ET21A1	4ET21A11	4ET21A2	4ET21A12

These crystal-controlled, phase-modulated transmitters employ a total of eight tubes (ET-20-A) or nine tubes (ET-21-A), two of which comprise the audio section and the remainder the RF section. The two-frequency transmitters employ an additional tube as the Channel B oscillator. By using external oscillators, three and four-frequency operation is also possible. The transmitter's quartz crystal carries a LIFETIME GUARANTEE.

The transmitter has been designed for maximum accessibility of tuning controls and components. All tubes and tuning controls are accessible from the top of the chassis, but no voltages are exposed above the chassis. All power and control connections to the transmitter are made through an 11-pin plug and cable (W101) to the power supply.

An RF indicator (I101) is included on the transmitter chassis to indicate the presence of RF voltage on the antenna lead. It may also be used as an auxiliary means of tuning the PA and its drive and the antenna circuit for maximum power to the antenna. Servicing is further simplified by using the Indicator to locate such faults as an open antenna circuit.

FIVE-STAR TUBES

The tubes employed in the transmitter are widely-accepted, highly efficient, long-life tubes which meet the requirements of the majority of installation. In certain installations, where the tubes will be subject to severe shock and vibration, it may prove more economical to employ General Electric "Five-Star Tubes". These tubes are more ruggedly constructed, must pass more rigid tests, and are carefully "aged" to eliminate early failures. This results in increased life, particularly under the severe vibration conditions sometimes encountered in mobile installations. The Five-Star Tubes which are available for use in this transmitter are listed below.

Prototype Tube	Five-Star Tube
6661/6BH6	GL-6265
6680/12AU7	GL-5814-A

For 6-volt operation, no modification is necessary on the transmitter after adding Five-Star Tubes. Since the Five-Star replacements for the 6BH6 and 12AU7 tubes draw slightly more filament current than their prototypes, heater unbalance will be experienced on 12-volt operation unless a balancing resistor is added in the filament circuit. Directions for making this modification on each transmitter model are given below.

Models 4ET20A1 or 2 - Add a 120-ohm ± 10%, 1-watt balancing resistor between pin 9 on tube socket XV109 and ground.

Models 4ET20A11 or 12 - Remove resistor R200 (39-ohm, 2 watt) from between pins 4-5 and pin 9 on XV109. Add a 51-ohm ± 10%, 2-watt balancing resistor between pins 5 and 9 on XV109.

Models 4ET21A1 or 2 - Add a 51-ohm ± 10%, 2-watt balancing resistor between pins 4-5 and 9 on tube socket XV109.

Models 4ET21A11 or 12 - Remove resistor R200 (39-ohm, 2-watt) from between pins 4, 5 and pin 9 on tube socket XV109. Add a 200-ohm ± 10%, 1/2-watt balancing resistor between pin 9 on tube socket XV109 and ground.

MAINTENANCE

To prevent undue interruption of the proper operation of the equipment, regular preventive maintenance procedures should be followed. This preventive maintenance should include the following.

1. A check of the operating frequency as required by the Federal Communications Commission.

2. Comparison of voltages read at the metering jacks with those given on back of SERVICE OUTLINE for the transmitter.

3. A check of the power amplifier tank tuning and realignment if improper operation is indicated.

4. Inspection for loose screws and nuts and broken cables and wires caused by shock or vibration in mobile units.

5. Measurement of the B-plus voltage on the transmitter power supply chassis.

6. Preventive maintenance on the battery, generator and voltage regulator when installed in a vehicle.

7. Cleaning of relay contacts if necessary.

CIRCUIT ANALYSIS

Transmitters ET-20-A and ET-21-A are crystal-controlled, phase-modulated transmitters having a nominal power output of 10/25 watts (ET-20-A) or 50 watts (ET-21-A). The crystals used fall in the range from 6.000 to 7.250 megacycles. The multiplier stages multiply the crystal frequency 24 times.

CRYSTAL OSCILLATOR

Keying the transmitter applies B-plus voltage to the crystal-oscillator, V101 (6BH6). The oscillator is of the electron-coupled type and uses a capacitive voltage divider feedback network consisting of C106 and the input capacitance of V101 to maintain oscillation. Heated ovens are available for maintaining the crystal temperature at 100°C (212°F), stabilizing the frequency against drift due to temperature change. In the single-frequency transmitter, the cathode circuit of V101 is continuously grounded by the jumper from TB-2-1 to ground. This jumper is not present in the two-frequency transmitter, and a second oscillator stage, V201 (6BH6), is used for operation on Channel B. The desired oscillator section can oscillate only when its cathode circuit is grounded by the Channel-Selector Switch on the control unit.

In two-frequency operation, the frequencies of the two channels should not be more than 0.65 megacycles apart. Since the transmitter has a crystal multiplication of 24, the crystal frequencies should not be more than 28 kilocycles apart. In installations in which slight de-rating of the transmitter output is permissible, greater frequency spreads may be used.

AUDIO AMPLIFIER

The audio signal entering the transmitter at P101-2 is applied to the audio amplifier, V110 (12AU7), and undergoes two stages of amplification. C173 and C179 are RF by-pass capacitors. From the audio amplifier, the signal passes to the modulation limiter, V109 (12AU7).

LIMITER AND MODULATOR

The phase modulator produces a peak frequency deviation proportional to both the peak voltage and the frequency of the audio signal applied. To limit the peak deviation to a given value, the product of the peak voltage and the frequency of the audio signal must not exceed some given figure. V109 is a voltage limiter which fixes the maximum peak voltage applied to the input of the de-emphasis network R196, R197, R198, R199, C191, C192, C193, C184. The de-emphasis network acts in such a way that, with a given voltage applied to its input, the output voltage across C184 is inversely proportional to its frequency (i.e., the higher the frequency, the lower the output voltage in direct proportion). Thus at the output of the de-emphasis network, the product of the peak voltage and its frequency can never exceed a certain value over the range of voice frequencies and the levels encountered in use. Since this constitutes the audio signal applied to the phase modulator, the peak deviation is limited to a value determined by circuit adjustment.

If the audio input to the transmitter is not great enough to cause limiting in V109, the limiter acts as a simple audio amplifier. In order to eliminate the effect of the de-emphasis network at these levels, the pre-emphasis network, C174 and R174, is included. For a fixed voltage applied across this network, the output voltage across R174 is directly proportional to its frequency. This action is the opposite of that of the de-emphasis network, so that, at audio levels below limiting, the two cancel and have no net effect upon the audio signal.

The RF output of the oscillator stage, which is developed across L108, is applied to the input of the phase modulator, the triode section of V102 (6U8). When an audio modulating voltage from the output of the de-emphasis network is also applied to the input of the modulator, the resulting modulator output is a phase-modulated RF signal (indirect FM), which is applied to the first multiplier, the pentode section of V102 (6U8). Potentiometer R186 controls the level of peak deviation.

MULTIPLIERS

The first multiplier is a frequency doubler, whose grid bias is self-developed across R115 and R117. The MULTI-1 metering jack is provided to observe proper operation of the oscillator and modulator stages. The tank circuit (Z101) is tuned to twice the crystal frequency by adjustment of the tuning slug in the coil (Z101-L1). The output of the first multiplier is capacitively coupled to the grid of the second multiplier through Z101-C1.

The second multiplier, V103 (6BH6), is a frequency tripler. Biasing is provided by R120 and R121. R121 is also used as MULT-2 metering resistor for tuning the first multiplier plate tank. The second multiplier plate tank (Z102) is tuned to six times the crystal frequency and is coupled to the third multiplier grid tank (Z103) by means of "low-side" capacitive coupling. A part of the RF voltage in the second multiplier plate circuit appears across C122 and C121 in parallel. Since C122 and C121 are also part of the third multiplier grid circuit, this RF voltage is coupled into the grid tank.

The third multiplier, V104 (6CL6), is a doubler. The MULT-3 jack is used in tuning the second multiplier plate tank coil (Z102) and the third multiplier grid tank coil (Z103). Z103-R1 and R128 are grid bias resistors. R127 is a grid loading resistor, used to prevent regeneration in the 6CL6 multiplier tube, which has a very high transconductance. The third multiplier plate tank (Z104) is tuned to twelve times the crystal frequency and is coupled to the fourth multiplier grid tank (Z105) by means of low-side capacitive coupling, in which C132 and C133 are the common coupling elements.

The fourth multiplier, V105 (2E26), is a doubler. Z105-R1 is its grid bias resistor and Z105-R2 and R135 comprise the metering network for the MULT-4 jack. The fourth multiplier plate tank circuit, L105 and C140, is tuned to 24 times the crystal frequency and is inductively coupled to the power amplifier grid tank coil (L106 or L118). The "printed-circuit" Faraday shield between the fourth multiplier plate coil and the PA grid coil eliminates capacitive coupling between the coils to reduce spurious radiation. In transmitter ET-21-A, the PA grid coil is broadly resonant and need not be adjusted unless the carrier frequency is greatly changed; therefore, no PA grid tuning control is provided. In transmitter ET-20-A, C154 is the PA GRID tuning control.

POWER AMPLIFIER

Transmitter Models 4ET20A1, 2, 11, and 12 employ a single 6146 power amplifier tube, V107, to obtain a nominal power output of 10/25 watts. Transmitter Models 4ET21A1, 2, 11 and 12 use two 6146 tubes, V107 and V108, in push-pull to obtain a nominal power output of 50 watts. The PA grid bias circuit in the ET-20-A is composed of R139, R140 and R141, with R139 also serving as the PA GRID metering resistor. In the ET-21-A, R146, R145 and R141 perform the same respective functions. Fixed bias is permanently applied to the grids of both the power amplifier and the fourth multiplier, as a protective measure. Consequently, there is a small residual meter reading at the MULT-4 jack and the PA GRID jack, even where no excitation is present. C149 and L110 (and C151 and L109 in transmitter ET-21-A) prevent self-oscillation of the power amplifier. A TUNE-OPERATE switch, S101, is provided to reduce the screen voltage on the 6146 power amplifier tube(s), protecting them from excessive plate current while the transmitter is being tuned.

The power amplifier plate tank coil is adjusted to approximately the correct frequency on transmitter ET-21-A by adjusting its shorting bar. C150 (on transmitter ET-21-A) or C157 (on transmitter ET-20-A) tunes the PA plate tank. The amount of inductive coupling between the plate tank coil and the antenna coil may be adjusted by means of the ANT COUPLING control, which varies the orientation of the antenna coil with respect to the PA plate tank coil. The ANT TUNING capacitor, C167 is used to tune out any reactance presented to the antenna circuit by an antenna feed cable having a standing-wave ratio greater than 1:1, a situation nearly always encountered in actual installations.

LOW-PASS FILTER, ANTENNA RELAY AND RF INDICATOR

Following the antenna coupling coil is a low-pass filter consisting of one constant-K and two M-derived full sections. Keying the transmitter energizes the antenna relay, K102, which switches the antenna from the receiver to the transmitter. The RF indicator, I101, is a neon-lamp used to indicate the presence of RF voltage on the antenna lead.

The RF low-pass filter incorporated in the design of the transmitter materially decreases spurious radiations. In systems where a transmitter and receiver, relatively close in distance and frequency operate simultaneously, it will be desirable to provide attenuation to prevent receiver desensitization. One solution would be to electrically replace the low-pass filter with a General Electric Cavity Filter Type KY-5-A. Removal of the low-pass filter is required to facilitate the determination of line lengths.

The cavity may be applied, with regard to the transmitter, in one of two manners depending upon the system and mode of operation. In simplex systems operating push-to-talk from the same antenna, Cavity Type KY-5-A may be installed in the antenna lead-in (transmission line) between the antenna and the antenna connector. In duplex systems, Cavity Type KY-5-A should be installed between the transmitter antenna coupling coil and the transmitter contact of the antenna-switching relay. When substituting a cavity for the low-pass filter, the cavity will provide as much or more attenuation to spurious radiation as the low pass filter.

When installing Cavity in Antenna lead-in to transmitter and receiver.

1. Remove the filter housing cover (smaller aluminum cover on underside of chassis) by depressing the spring clips and pulling housing out.

2. Unsolder lead to filter coming from antenna coupling coil.

3. Unsolder lead to filter coming from antenna switching relay (mounted adjacent to filter).

4. Remove components of filter.

5. Mount Winchester insulated stand-offs, or equivalent, using mounting holes formerly occupied by stand-off capacitors C161 and C166.

6. Terminate leads removed by steps 2 and 3 in stand-offs and solder a piece of wire between the two stand-offs.

7. Replace filter housing.

8. Connect cavity between antenna and antenna connector. Refer to cavity Instructions for Installation and Tuning Instruction.

When installing cavity between the transmitter antenna coupling coil and the transmitter contact of the Antenna Switching relay:

1. Follow steps 1 through 4 of above procedure.

2. Fashion a bracket to contain two Amphenol Type 83-1R receptacles for mounting in the space formerly occupied by the filter. The bracket illustrated and dimensioned below is suggested as ideal for Progress Line Receivers. Punch or saw two 3/4-inch holes in the top of the filter cover as illustrated below. Mount Type 83-1R receptacles to the bracket.

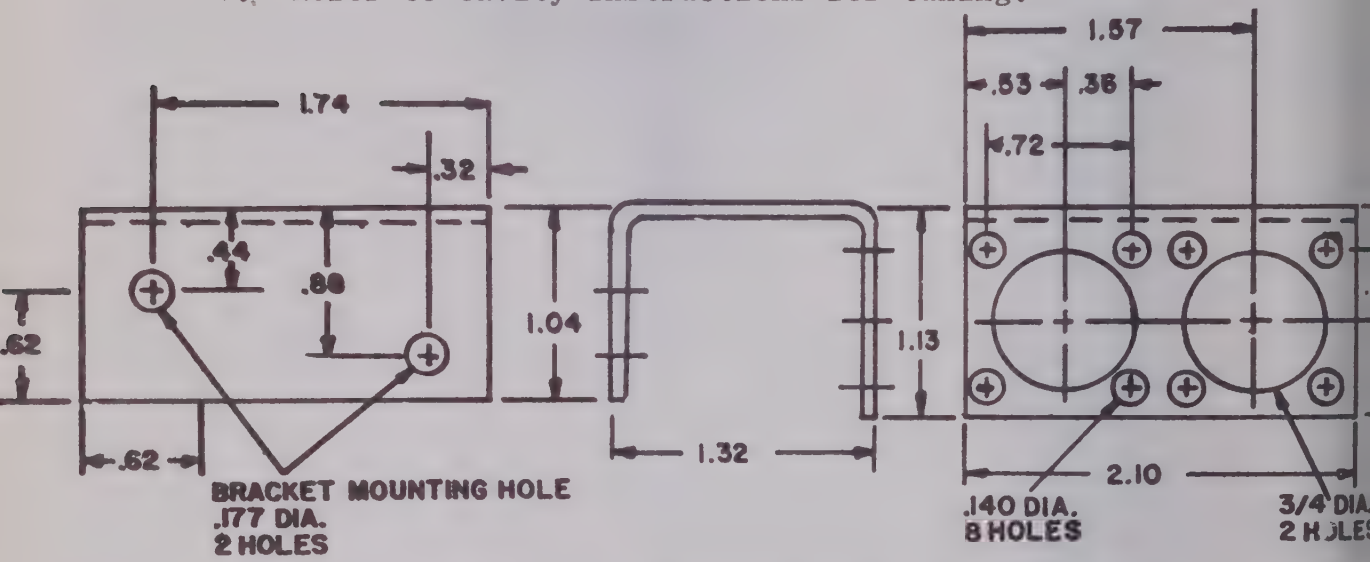
3. Mount the bracket to the transmitter chassis in the space formerly occupied by the low pass-filter, using the mounting holes already in the chassis.

4. Solder lead from antenna coupling coil to closest bracket receptacle. Solder lead from antenna switching relay to other bracket receptacle.

5. Re-mount filter housing cover.

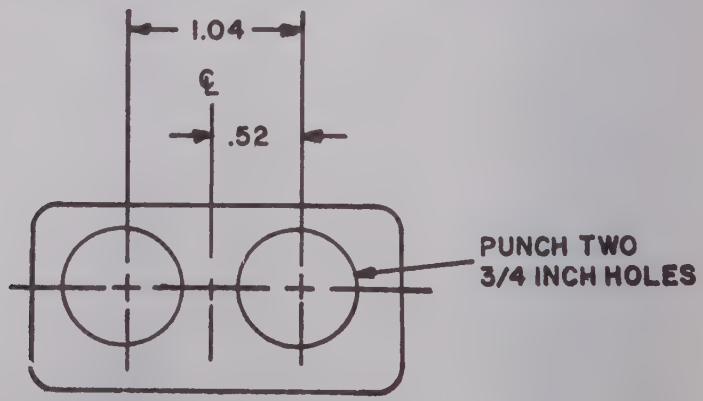
6. Connect the cavity between the two receptacles on special mounting bracket and make antenna connections as for normal installation.

7. Refer to Cavity Instructions for tuning.



MATERIAL: COMMERCIAL QUALITY COLD ROLLED LOW CARBON SHEET STEEL .050 THICK, .03 BEND RADIUS.
FINISH: CADMIUM PLATE

SUGGESTED BRACKET FOR CAVITY APPLICATION



TOP OF FILTER HOUSING

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

Printed in U.S.A.

BENCH ALIGNMENT PROCEDURE FOR TRANSMITTER MODELS 4ET20A1, 2, 11 & 12 AND 4ET21A1, 2, 11 & 12

This Bench Alignment Procedure is provided for completely realigning Transmitter Models 4ET20A1, 2, 11 & 12 and 4ET21A1, 2, 11 & 12 or for changing their frequency. Instructions for adjusting the modulation level are also included.

ALIGNMENT PROCEDURE

TEST EQUIPMENT

The transmitter can be completely realigned, using a 20,000 ohm-per-volt voltmeter which covers the 0 to 3-volt range. The voltage indications given in the following alignment procedure are the values which should be read on such a meter. General Electric Test Set Type EX-1-C is an instrument designed for the many metering applications encountered when tuning Radio Communication and associated equipment and includes a 20,000 ohm-per-volt meter.

If a meter equivalent to the one suggested is not available for tuning purposes, others may be used, but the meter reading obtained must be corrected to account for the shunting effect of the different meter resistance on the metering circuit.

The following test equipment is recommended:

1. A 20,000 ohm-per-volt meter, such as the G-E Test Set Type EX-1-C, which covers the 0 to 3-volt range.

2. A non-metallic screwdriver.

3. A frequency measuring device, such as Lampkin Type 105B or Gertsch Model FM-3.

4. An absorption wavemeter which will tune to 2, 6, 12 and 24 times the crystal frequency.

PROCEDURE

Refer to SERVICE OUTLINE RC-344 (see Table of Contents) to locate the tuning controls referred to in the following alignment procedure. All meter readings are measured between the jack indicated and ground.

1. Be sure that the oscillator crystal(s) is (are) correctly connected between the points shown in the following table. The crystal frequency for each channel is 1/24th of the channel frequency. XY2101 and XY2102 are located on the Multi-Frequency Adapter.

Crystal	Single-Frequency and Two-Frequency Transmitters	Three-Frequency and Four-Frequency Transmitters
CHAN A	XY101-4 and 6	XY2101-4 and 6
CHAN B	XY101-2 and 8 (2-Freq. only)	XY2101-2 and 8
CHAN C		XY2102-4 and 6
CHAN D		XY2102-2 and 8 (4-Freq. only)

2. In multi-frequency transmitters, turn the Channel-Selector Switch on the Control Unit to CHAN A, if the greatest frequency separation between channels is less than 0.4% of the operating frequency. (Select the channel having the lowest frequency if CHAN A is not the lowest.) For frequency separations greater than 0.4%, a crystal having a frequency which is the average of the crystal frequencies for the highest and lowest channels should be used to align the transmitter.

3. Connect the antenna or another load to the transmitter.

4. Set the TUNE-OPERATE switch (S101 on the PA housing) on TUNE.

5. Rotate the ANT COUPLING control to its extreme clockwise position.

6. Turn the power on and allow 30 seconds for the transmitter to warm up to operating temperature.

7. A voltage reading of approximately 1.0 volts between the MULT-1 jack, J101 (green-negative), and ground when the transmitter is keyed indicates proper operation of the Oscillator and Modulator stages of the transmitter. Use the ground jack located on the power supply chassis.

8. With the meter lead moved to the MULT-2 jack, J102 (green-negative), key the transmitter and tune Z101 ("1") for maximum meter reading (approximately 1.6 volts).

CAUTION

Do not key the transmitter for longer than 30 seconds in each minute until the 4th Multiplier plate has been tuned.

9. Alternately tune Z102 ("2") and Z103 ("3") for maximum meter reading (approximately 1.8 volts) at the MULT-3 jack, J103 (green-negative).

When making a great change in frequency, it may not be possible to see any indication on the meter when Z102 is tuned, unless Z-103 is tuned near the correct frequency. In this case, pretune Z102 by one of the following methods:

(a) With the 300-volt scale of a vacuum tube voltmeter or a 20,000 ohm-per-volt voltmeter connected at the screen of the 2nd Multiplier (pin 6 of XV103), tune Z102 ("2") for a slight dip in screen voltage.

(b) Hold an absorption wavemeter close to the bottom of Z102, and tune for resonance.

It is possible to tune Z102 and Z103 to the wrong harmonic of the crystal frequency. Z102 and Z103 will ordinarily be correctly tuned if their slugs are first screwed all the way out and then screwed in to the first indication of resonance. Check the tuning with a wavemeter.

10. Alternately peak Z104 ("4") and Z105 ("5") while metering at the MULT-4 jack. J104 (green-negative). Fixed bias on the MULT-4 grid will appear as a small initial reading (0.5-1.0 volt) at J104, whether or not Z104 and Z105 are correctly tuned. The meter should read approximately 1.6 volts for proper tuning.

A slight dip at J103 may be used as an indication of resonance of Z104 if both Z104 and Z105 are badly misaligned.

NOTE

In mobile installations, the transmitter must be either in its case or standing on a metal base plate while the MULT-4 PLATE control (and, in Transmitter Type ET-20-A, the PA GRID control) is being tuned. Otherwise, these controls will be detuned when the unit is returned to its case.

11. Peak the MULT-4 PLATE control (C140) while metering at the PA GRID jack, J105 (green-negative). In Transmitter ET-20-A, also peak the PA GRID tuning control (C154). Fixed bias on the PA grid will appear as a small initial reading at J105, whether or not the MULT-4 PLATE control is correctly tuned.

In the ET-21-A, L106, the PA grid tank coil (located in front of the "printed circuit" Faraday shield and between the PA tube sockets) may also need to be adjusted for maximum reading at the PA GRID jack, if making a great change in frequency.

WARNING

HIGH VOLTAGE is present under the transmitter chassis. Disconnect all power from the transmitter before proceeding.

For a transmitter operating between 165 and 174 megacycles, the turns should be spread as far apart as possible. The spacing between coils L105 and L106 should also be adjusted for maximum meter reading. At this point, with the transmitter operating on TUNE and the PA plate untuned, the meter should read at least:

152 MC - 2.8 volts
162 MC - 2.6 volts
174 MC - 2.2 volts

These are minimum readings and the operator should try to exceed them.

12. Repeak the MULT-4 PLATE and the PA GRID (ET-20-A) or L106 (ET-21).

13. ET-21-A only - DISCONNECT ALL POWER FROM THE TRANSMITTER. Remove the PA tuner shield and ground one of the PA tube plate caps with an insulated screwdriver. Adjust the PA plate shorting bar on L113 for the correct frequency. At 152 megacycles, the bar should be 1/8-inch above the bend in L113. At 174 megacycles, the bar should be about level with the lower end of the Textolite* shaft on the ANT COUPLING control. For other frequencies, adjust the bar proportionately between these extremes. Replace the PA shield.

*Registered U.S. Patent Office.

14. Connect the meter leads between the CATH PA jack, J106 (red-positive), and ground, key the transmitter and tune the PA PLATE control (C150 or C157) for minimum meter reading.

15. Switch the TUNE-OPERATE switch to OPERATE, and quickly tune the MULT-4 PLATE (and, in the ET-20-A, the PA GRID) for minimum meter reading at the CATH PA jack.

16. Alternately tune the PA PLATE and ANT TUNING controls for minimum CATH PA current.

17. Tune the ANT TUNING control for maximum CATH PA current. If no peak is observed, rotate the ANT COUPLING control slightly counterclockwise and peak the ANT TUNING control.

18. Rotate the ANT COUPLING control counterclockwise until the CATH PA meter reads 1.4 volts (on 25 or 50-watt transmitters) or 1.0 volt (on 10-watt transmitters).

19. Repeak the ANT TUNING control.

20. ET-20-A - Ajdust the ANT COUPLING control for CATH PA meter reading of 1.6 volts when used with a medium-power power supply (25 watts) or 1.1 volts when used with a city-power power supply (10 watts).

ET-21-A - Adjust the ANT COUPLING control for CATH PA meter reading of 1.5 volts.

21. Retune the MULT-4 PLATE control (C140) and the PA GRID control (ET-20-A) for maximum reading at the PA GRID jack, J105 (green-negative). The reading should be approximately 1.0-2.0 volts on transmitter ET-20-A or approximately 1.8-2.6 volts on transmitter ET-21-A.

22. Alternately repeat Step 19 and Step 20 until no further change in meter reading is obtained.

23. Check the frequency of the transmitter. In single-frequency and two-frequency transmitters adjust the FREQ ADJ A control, if necessary, to set Channel A on frequency. In two-frequency transmitters, check Channel B also and set it on frequency by means of the FREQ ADJ B control. The frequency of three and four-frequency transmitters should also be checked and adjusted, if necessary, on the Multi-Frequency Adapter.

PA ALIGNMENT USING RF INDICATOR LAMP

The neon glow RF indicator, I101, located on the chassis near the PA housing, is intended to indicate only the presence or absence of RF power on the antenna lead. In an emergency however, when the power amplifier must be aligned and there is no other means at hand, I101 may be used as a tuning indicator. The transmitter must already be roughly aligned and the procedure below must be followed.

1. Set the TUNE-OPERATE switch on OPERATE and turn the ANT COUPLING control fully clockwise.

2. Key the transmitter, and alternately adjust the PA PLATE and the ANT TUNING controls for minimum brightness of I101. (If tuning the PA PLATE causes I101 to go out, set the PA PLATE at a point mid-way between the points at which I101 goes out.)

3. Adjust the ANT TUNING control for maximum brightness. (If no change is noticed, rotate the ANT COUPLING control slightly counterclockwise until an indication can be seen as the ANT TUNING control is adjusted.)

4. Rotate the ANT COUPLING for maximum brightness.

5. Tune the MULT-4 PLATE (and, in Transmitter Type ET-20-A, the PA GRID) for maximum brightness.

6. Readjust the ANT COUPLING and the ANT TUNING for maximum brightness.

The transmitter is now aligned and delivering maximum power to the load. However, since I101 gives no indication of the actual value of plate current being drawn, it is advisable to continue with the next step, to lessen the possibility of exceeding the PA tube ratings.

7. Back the ANT COUPLING off in a clockwise direction until a slight decrease in the brilliance of I101 is noted.

MODULATION LEVEL ADJUSTMENT

The modulation level control, R186, was adjusted to the proper setting before shipment and should not normally require re-adjustment. This setting permits approximately 60 percent modulation for the average voice level. The occasional audio peaks which would cause overmodulation are limited by the modulation limiter (V109). The limiter instantaneously limits the slope of the audio wave, preventing overmodulation, but preserving the intelligibility of the transmission.

TEST EQUIPMENT

1. An audio oscillator.

2. A frequency modulation monitor.

3. An output meter or a vacuum tube voltmeter.

PROCEDURE

1. Connect the audio oscillator and the meter across pins 1 and 2 of the microphone receptacle on the power supply chassis. (Pin 1 is the audio low.)

2. Apply a 1.0-volt signal at 1000 cps across the microphone terminals.

3. Disconnect the microphone from the control unit, and key the transmitter by means of the test switch on mobile transmitters or by grounding pin 3 of the microphone jack in station transmitters.

4. Set R186, the MOD control, for a 13 to 15-kilocycle swing (5-kilocycles for Narrow-Band) as indicated on the frequency modulation monitor.

If no audio oscillator is available, the modulation level control can be set by connecting a microphone to the transmitter, whistling a loud, clear tone into the microphone, and setting the MOD control (R186) for a 13 to 15-kilocycle swing*, as indicated on the modulation monitor.

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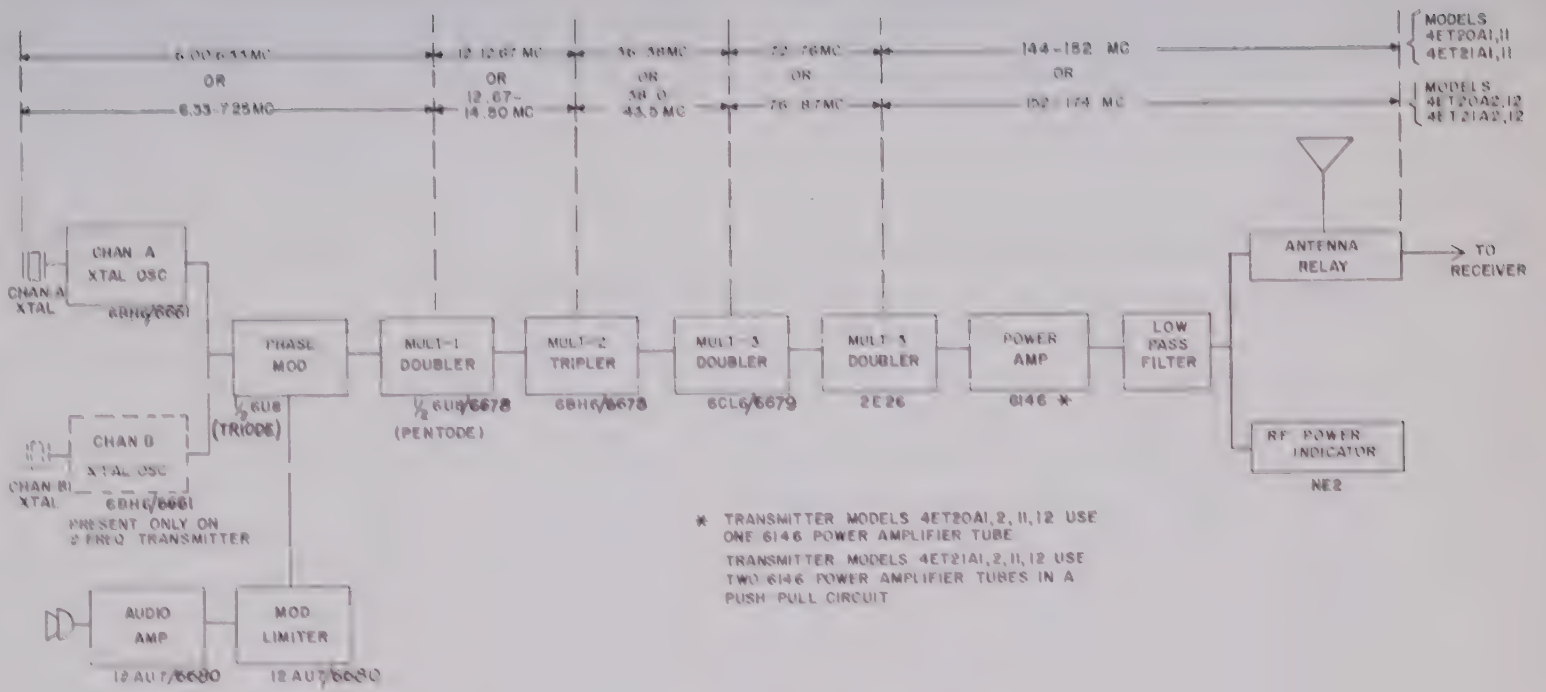
*Because of the high selectivity of General Electric Mobile Radio equipment, excessively high swings can impair communication effectiveness as well as excessively low swings. Within the range of settings recommended, good performance should be obtained. In general, more problems arise from high swing settings than from low; for this reason, the modulation control is set for ± 13 kilocycles ± 5 kilocycles for Narrow-Band) when the equipment is shipped from the factory.

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

Printed in U.S.A.



Block Diagram
for
144-152 MC TRANSMITTERS
MODELS 4ET20A1, 2, 11, 12
MODELS 4ET21A1, 2, 11, 12
MODELS 4ET20A2, 12 & 4ET21A2, 12

(DC-5334)

(D-7668907, Rev. 10)

TYPICAL VOLTAGE READINGS FROM TUBE SOCKET PINS TO GND.

	9	8	7	6	5	4	3	2	1	SYMBOL	TUBE TYPE
③④	—	—	155	155	①	②	②	.05	①	V101	6BH6
	—	—	155	155	200	②	②	7	①	V201	6BH6
①	9	0	①	②	②	75	①	200	①	V102	6U8
	—	—	215	①	②	②	0	①	V103	6BH6
①	210	0	①	②	②	20	①	15	V104	6CL6
	—	0	②	0	①	0	200	②	0	V106	2E26
	—	0	②	1.5	①	1.5	160	②	1.5	V107	6146
	—	0	②	1.5	①	1.5	160	②	1.5	V108	6146
④	—	6.8	0	150	②	②	3.0	-0.6	65	V109	12AU7
②	④	3.6	0	85	②	②	1	0	42	V110	12AU7

	9	8	7	6	5	4	3	2	1	SYMBOL	TUBE TYPE
③	—	—	∞	∞	∞	∞	∞	100K	4	V101	6BH6
	—	—	∞	∞	∞	∞	∞	100K	∞	V201	6BH6
③	—	—	∞	∞	∞	⑤	⑤	200K	500K⑥	V102	6U8
	—	—	0	3300	400K⑦	130K⑥	⑤	100K	0	V103	6BH6
	—	—	0	0	⑤	120K⑥	190K⑥	0	⑤	V104	6CL6
	—	160K⑥	80K	0	⑤	150K⑥	⑤	560	80K	160K⑥	2E26
	—	—	0	⑤	0	40K	0	⑤	170K⑥	0	6146
	—	0	⑤	0	⑤	17K	5	⑤	300K⑥	5	6146
	—	0	⑤	0	⑤	17K	5	⑤	300K⑥	5	6146
④	②	47K	3900	⑤	180K⑥	⑤	3900	570K	380K⑥	5	12AU7
②	④	100K	2200	⑤	240K⑥	⑤	470	100K	240K⑥	5	12AU7

READINGS ARE TYPICAL VOLTAGES MEASURED ON A 20,000 OHM-PER-VOLT VOLTMETER (SCALES OF 3,12,60, 300,600 VOLTS) WITH THE TRANSMITTER LOADED TO RATED CATHODE CURRENT.

① MEASUREMENT OF VOLTAGE AT THIS POINT WOULD UPSET OPERATION OF CIRCUIT.

② FILAMENT CIRCUIT. ON 6-V BATTERY, PIN CONNECTED WITH ORANGE WIRE READS 0V; ON 12-V BATTERY, PIN CONNECTED WITH ORANGE WIRE READS ABOUT 12.6V. PIN CONNECTED WITH BROWN WIRE READS ABOUT 5.6 V WITH 6-V BATTERY AND ABOUT 6.3 V WITH 12-V BATTERY.

③ CHANNEL SELECTOR SWITCH ON CHAN A (2-FREQUENCY TRANSMITTER).

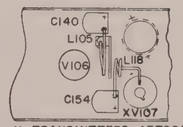
④ NO MODULATION

READINGS ARE TYPICAL RESISTANCES MEASURED WITH ALL POWER REMOVED FROM TRANSMITTER AND WITH CABLES CONNECTED AND TUBES IN PLACE.

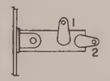
⑤ FILAMENT CIRCUIT.

⑥ CAPACITOR CHARGING WILL AFFECT READING WHEN ALLOW METER TO RISE TO HIGHEST READING.

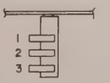
⑦ MOD CONTROL TURNED FULLY CLOCKWISE.



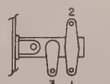
* TRANSMITTERS 4ET20A2 AND I2 ARE SIMILAR TO TRANSMITTERS 4ET2IA2 AND I2 EXCEPT FOR THE DIFFERENCES SHOWN ABOVE.



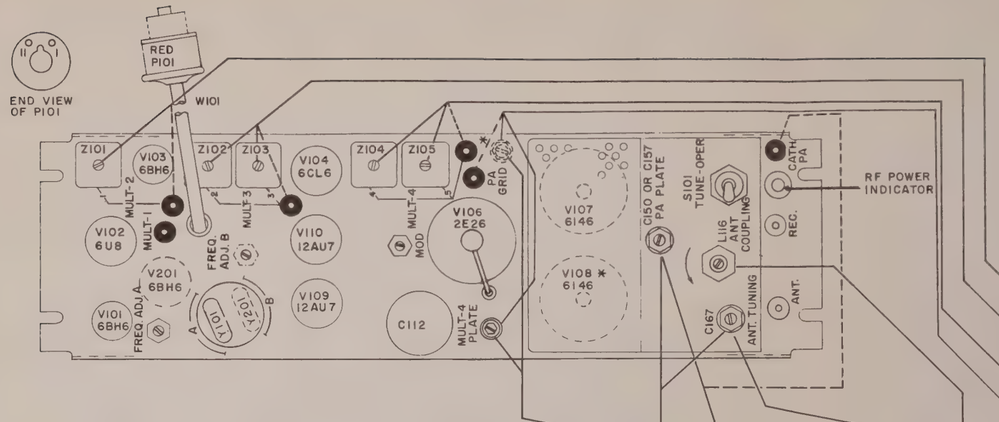
TERMINAL VIEW OF TB7, T88, TB13 AND TB15.



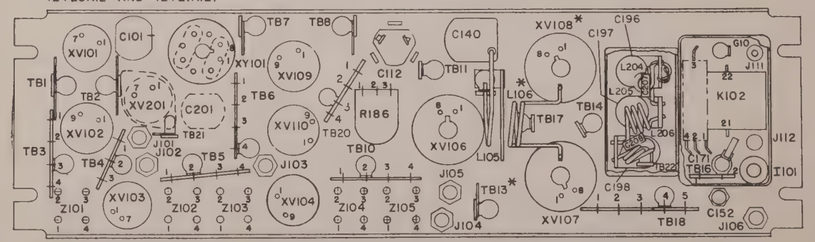
TERMINAL VIEW OF TB2I



TERMINAL VIEW OF TBI AND TB2



V201, XV201, C201 AND Y201 ARE PRESENT ONLY ON 2-FREQUENCY TRANSMITTERS 4ET20AI2 AND 4ET2IAI2.



SIMPLIFIED BENCH ALIGNMENT PROCEDURE

These instructions are intended for retuning Transmitter ET-20-A and ET-21-A. If the transmitter is badly misaligned, or if the frequency of the transmitter is to be changed, refer to the complete TRANSMITTER BENCH ALIGNMENT PROCEDURE (see Table of Contents).

PRELIMINARY OPERATIONS

1. Be sure CRYSTAL is connected between pins 4 and 6 of crystal socket XY101 (Channel B crystal between pins 2 and 8 for two-frequency operation) and ANTENNA or other load is connected to transmitter.

2. Place TUNE-OPERATE switch in TUNE position.

3. Rotate ANT COUPLING control to its extreme CLOCKWISE position.

4. Turn POWER ON and allow 30 seconds for WARMUP.

5. On two-frequency transmitters, turn Channel Selector Switch to CHANNEL A.

6. Check oscillator frequency using an approved frequency meter. If necessary, set transmitter on frequency by means of crystal trimmer FREQ ADJ A (C101).

NOTE: Do not key the transmitter for longer than 30 seconds in each minute until the 4th Multiplier Plate has been tuned.

The transmitter can be completely tuned using the 0 to 3-volt scale of a 20,000 ohm-per-volt voltmeter. The meter readings given are those which should be obtained using such a meter.

METERING JACK		TUNING CONTROL	METER READING	PROCEDURE
—	+			
MULT-1 J101 green	GND J508 black			A meter reading of approximately 1.5 volts or more indicates proper operation of Oscillator and Modulator stages. GND jack J508 is located on Power Supply chassis.
MULT-2 J102 green	"	Z101-L1 (1) (Mult-1 Plate)	Maximum (1.6 volts *)	
MULT-3 J103 green	"	Z102-L1 (2) (Mult-2 Plate) Z103-L1 (3) (Mult-3 Grid)	Maximum (1.6 volts *)	Alternately peak Z102 and Z103. If both Z102 and Z103 are badly misaligned, refer to TRANSMITTER BENCH ALIGNMENT PROCEDURE. Check tuning with wavemeter.
MULT-4 J104 green	"	Z104-L1 (4) (Mult-3 Plate) Z105-L1 (5) (Mult-4 Grid)	Maximum (1.6 volts *)	Alternately peak Z104 and Z105. If necessary, pretune Z104 by tuning for dip at J103. Fixed bias on Mult-4 grid will appear as small reading (0.5 to 1.0 volt) at J104, whether or not Z104 and Z105 are tuned.
PA GRID J105 green	"	MULT-4 PLATE and PA GRID (in ET-20-A only)	Maximum	Fixed bias on PA grid will appear as small initial reading at PA Grid jack. When changing frequency of Transmitter Model ET-21-A, coil spacing of L106 and shorting bar on L113 must be adjusted as directed in TRANSMITTER BENCH ALIGNMENT PROCEDURE.
GND J508 black	CATH PA J106 red	PA PLATE (C150 or C157)	Minimum (DIP)	
"	"	MULT-4 PLATE (C1L0) and PA GRID (ET-20-A only)	Minimum (DIP)	Dip MULT-4 PLATE and PA GRID controls, turn TUNE-OPERATE switch to OPERATE, and quickly redip tuning controls.
"	"	PA PLATE (C150 or C157) and ANT TUNING (C153)	Minimum (DIP)	Tune PA PLATE and ANT TUNING controls alternately until lower meter reading cannot be obtained.
"	"	ANT TUNING (C153)	Maximum	If no peak is observed, increase setting of ANT COUPLING control slightly until ANT TUNING control may be tuned for slight peak.
"	"	ANT COUPLING (L111)	1.1 volts	
"	"	ANT TUNING (C153)	Maximum	
"	"	ANT COUPLING (L111)	1.6 volts in ET-20-A 1.5 volts in ET-21-A	
PA GRID J105 green	GND J508 black	MULT-4 PLATE (C1L0) and PA GRID (ET-20-A only)	Maximum (1-1.5 volts in ET-20-A)* (2 volts ET-21-A)*	
GND J508 black	CATH PA J106 red	ANT TUNING (C153)	Maximum	
"	"	ANT COUPLING (L111)	1.6 volts in ET-20-A 1.5 volts in ET-21-A	

* Approximate meter reading to be expected when tuning with 0 to 3-volt, 20,000 ohm-per-volt voltmeter. If possible, tune to exceed given reading.

——— SOLID LINES INDICATE TUNING CONTROLS.

– – – – BROKEN LINES INDICATE METERING JACKS.

Service Outline

144-152 MC TRANSMITTER MODELS 4ET20 & 21A1, 11
152-174 MC TRANSMITTER MODELS 4ET20 & 21A2, 12

(RC-344H)

HINTS FOR SERVICING

The following list of service hints, in addition to the table of typical metering voltages and the voltage-resistance chart (see reverse side) will assist the serviceman in locating the source of trouble if the Transmitter should fail to operate properly.

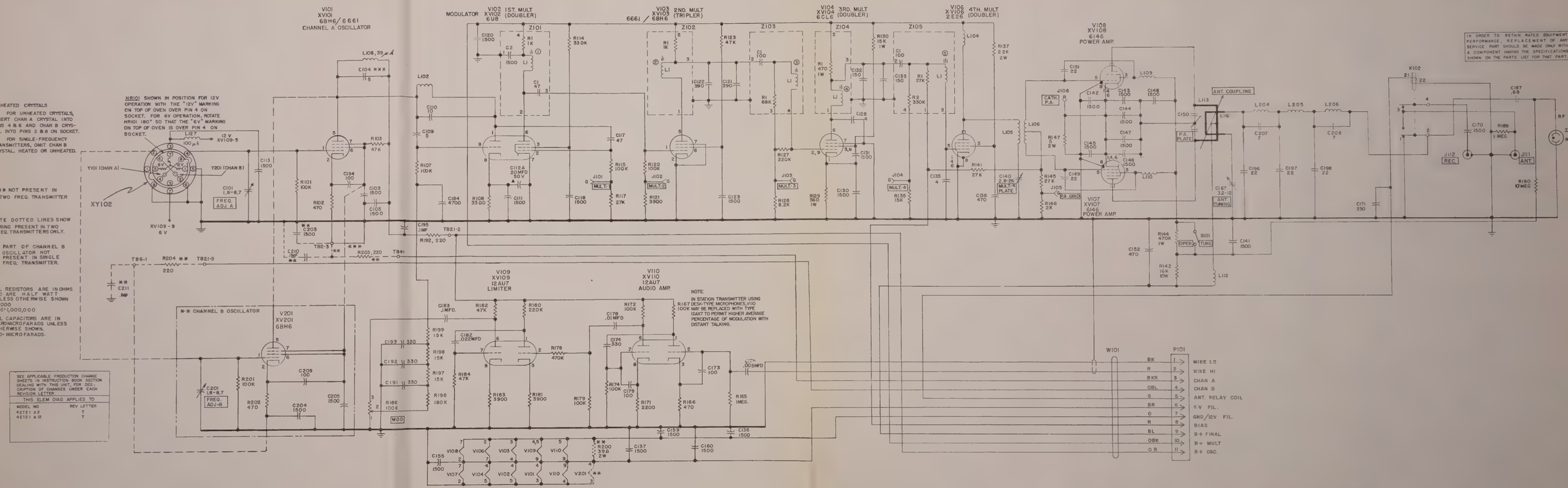
SYMPTOM	POSSIBLE CAUSE
No filament or B-plus voltage.	Power Supply failure. (a) Refer to SERVICE OUTLINE for transmitter Power Supply.
Low filament or B-plus voltage.	Fault in Power Supply. (a) Refer to SERVICE OUTLINE for transmitter Power Supply.
	Defect in B-plus or filament circuits causing excessive current drain.
	Power amplifier stage not properly tuned. (a) Retune PA.
No grid voltage at J101, the MULT-1 jack.	Defect in oscillator or modulator stage. (a) Test oscillator and modulator tubes. (b) If possible, test crystal by replacement with one known to be good. (c) Crystal plugged into wrong socket pins.
	Faulty relay contacts.
Low grid voltage in multiplier or power amplifier stages.	Defect in preceding stage. (a) Test the tube used in preceding stage and in stage under test. (b) Retune preceding stage; check tuning of coils with a wavemeter.
Good meter reading at J103, but no drive to 2E26 (J104).	Z103 and Z104 tuned to wrong harmonic of crystal frequency. (a) Check tuning of Z103 and Z104 with a wavemeter.
Power amplifier fails to load properly.	Defective power amplifier tube. (a) Try new power amplifier tube(s).
	Low grid voltage on power amplifier tube(s). (a) Check tuning of multiplier stages. (b) Check B-plus voltage.

SYMPTOM	POSSIBLE CAUSE
Continued.	Open antenna circuit. (a) Check antenna connections. (b) Check antenna relay.
	Low-pass filter short circuited.
Transmitter operating without modulation or with low modulation.	Defect in microphone circuit. (a) Check position of MOD control (R186). (b) Check microphone, microphone cable and plug for open or short circuit. (c) Check control cable for open or short in microphone leads. (d) Test audio amplifier, modulation and limiter tubes.
Excessive swing.	R186 improperly set. (a) Reset MOD control using FM monitor. (b) Deemphasis capacitor C184 open.
Transmitter fails to key properly.	Defect in keying relay. (a) Refer to SERVICE OUTLINE for Power Supply.
	Defect in antenna relay circuit. (a) Check contacts on antenna relay (K101).

TYPICAL METERING VOLTAGES

JACK		CIRCUIT	METER READINGS*	
			4ET20A2, 12	4ET21A2, 12
MULT-1	J101	Mult-1 Grid (Doubler)	1.5 volts	1.5 volts
MULT-2	J102	Mult-2 Grid (Tripler)	1.6 volts	1.6 volts
MULT-3	J103	Mult-3 Grid (Doubler)	1.8 volts	1.8 volts
MULT-4	J104	Mult-4 Grid (Doubler)	1.6 volts	1.6 volts
PA GRID	J105	PA Grid	1-1.5 volts	2.2 volts
CATH PA	J106	PA Cathode	1.6 volts	1.5 volts

* Typical meter readings on 0 to 3-volt scale of a 20,000 ohm-per-volt voltmeter.


V101 XV101 6BH6/6661 CHANNEL A OSCILLATOR
MODULATOR
V102 1ST. MULT (DOUBLER) XV102 6U8
V103 XV103 6BH6 6661 2ND. MULT (TRIPLER)
V104 XV104 6CL6 3RD. MULT (DOUBLER)
V106 XV106 2E26 4TH. MULT (DOUBLER)
V108 XV108 6146 POWER AMP.
V107 XV107 6146 POWER AMP.
V109 XV109 12AU7 LIMITER
V110 XV110 12AU7 AUDIO AMP.
V201 XV201 6BH6
** CHANNEL B OSCILLATOR
HEATED CRYSTALS
FOR UNHEATED CRYSTALS, INSERT CHAN A CRYSTAL INTO PINS 4 & 6 AND CHAN B CRYSTAL INTO PINS 2 & 8 ON SOCKET.
FOR SINGLE-FREQUENCY TRANSMITTERS, OMIT CHAN B CRYSTAL, HEATED OR UNHEATED.
*** NOT PRESENT IN IN TWO FREQ. TRANSMITTER
NOTE DOTTED LINES SHOW WIRING PRESENT IN TWO FREQ. TRANSMITTERS ONLY.
** PART OF CHANNEL B OSCILLATOR NOT PRESENT IN SINGLE FREQ. TRANSMITTER.
ALL RESISTORS ARE IN OHMS AND ARE HALF WATT UNLESS OTHERWISE SHOWN
K= 1000
MEG= 1,000,000
ALL CAPACITORS ARE IN MICROMICROFARADS UNLESS OTHERWISE SHOWN.
MFD= MICROFARADS.
HR101 SHOWN IN POSITION FOR 12V OPERATION WITH THE "12V" MARKING ON TOP OF OVEN OVER PIN 4 ON SOCKET. FOR 6V OPERATION, ROTATE HR101 180° SO THAT THE "6V" MARKING ON TOP OF OVEN IS OVER PIN 4 ON SOCKET.
XY102
Y101 (CHAN A)
Y201 (CHAN B)
XV109-9 6V
12V XV109-5
FREQ. ADJ. A
FREQ. ADJ-B
MOD
NOTE: IN STATION TRANSMITTER USING R167 DESK-TYPE MICROPHONES, V110 100K MAY BE REPLACED WITH TYPE 12AX7 TO PERMIT HIGHER AVERAGE PERCENTAGE OF MODULATION WITH DISTANT TALKING.
ANT. COUPLING
ANT. TUNING
P.A. PLATE
MULT-1
MULT-2
MULT-3
MULT-4
MULT-5 PLATE
P.A. GRID
CATH. P.A.
OPER
TUNE
REC.
ANT.
W101
P101
BK 1 MIKE LO
R 2 MIKE HI
BKR 3 CHAN A
OBL 4 CHAN B
G 5 ANT. RELAY COIL
BR 6 F-V FIL.
O 7 GND/12V FIL.
R 8 BIAS
BL 9 B+ FINAL
OBK 10 B+ MULT
O R 11 B+ OSC.
IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.
SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.
THIS ELEM DIAG APPLIES TO
MODEL NO 4ET21 A2 4ET21 A12
REV LETTER T T

Elementary Diagram

152-174 MC, 40-50 WATT
TRANSMITTER MODELS 4ET21A2, 12; REV. T

(DD-7668901, Rev. 23)

PARTS LIST

152-174 MC TRANSMITTER

MODEL 4ET21A2, REV. T (Single-Frequency)
MODEL 4ET21A12, REV. T (Two-Frequency)

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	CAPACITORS	
C101	Variable, air 1.98 to 7.83 mmfd, 1250 v d-c peak. Johnson Cat. #160-104-4S.	M-7481115-P2
C102#	Deleted by Rev. G	
C103	Ceramic high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C104	Ceramic, temp compensating tubular 5.0 mmfd ± 0.5 mmfd, 500 v d-c w. (Single frequency use only.)	P-7770468-P5
C105	Ceramic High K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C106#	Deleted by Rev. Q.	
C109	Ceramic, temp compensating tubular; 5.0 mmfd ± 0.5 mmfd, 500 v d-c w.	P-7770468-P5
C110	Ceramic, temp compensating tubular; 10 mmfd ± 0.5 mmfd, 500 v d-c w.	P-7770468-P10
C111	Ceramic, high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C112	Electrolytic, polarized twist prong base, 10 mfd +50% -10%, 400 v d-c w/20 mfd +250% -10%, 50 v d-c w.	P-7770994-P19
C113#	Ceramic, Hi-K disk; 0.0015 mfd +100% -0%, 500 v d-c w. Added by Rev. T.	C-7774750-P5
C117	Ceramic, temp compensating tubular; 47 mmfd ± 10%, 500 v d-c w.	P-7770468-P17
C118 and C120	Ceramic, high K disk; 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C121 and C122	Mica, Class C; 390 mfd ± 5%, 500 v d-c w. RETMA Type RCM20C391J.	P-3R141-P141
C123	Ceramic High K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C129#	Deleted by Rev. M.	
C130 and C131	Ceramic high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C132 and C133	Silver mica, CM 15 case, 150 mmfd ±5%, 500 v d-c w. Electro Motive Mfg. Type CM-15	P-3R122-P51
C135#	Ceramic tubular temp compensating, 4.0 mmfd ± 0.5 mmfd, 500 v d-c w. Added by Rev. A.	P-7770468-P4
C136#	Ceramic, Hi-K disk; 0.0015 mfd +100% -0%, 500 v d-c w. Added by Rev. M.	C-7774750-P5
C137	Ceramic high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C138	Ceramic, Hi-K, 470 mmfd ± 20%, 500 v d-c w. Erie Style 331 Hi-K.	M-7483722-P5
C140	Variable, air, 2.8 to 26 mmfd. Hammarlund Type MAPC-25.	M-7484307-P2
C141#	Ceramic, Hi-K disk, 0.0015 mfd +100% -0%, 500 v d-c w. Added by Rev. C.	C-7774750-P5
C142 thru C148	Ceramic, high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C149	Ceramic, temp compensating tubular; 22 mmfd ± 10%, 500 v d-c w.	P-7770468-P13
C150	Variable, air, 2.97 to 9.72 mmfd, 1250 v d-c peak, butterfly type. Johnson Cat. # 160-211-53.	B-5490272-P8
C151	Ceramic, temp compensating tubular, 22 mmfd ± 10%, 500 v d-c w.	P-7770468-P13
C152	Ceramic, feed thru type, 470 mmfd ± 20%, 750 v d-c w. Erie Style 327.	B-7485975-P17
C153#	Deleted by Rev. F.	
C155	Ceramic high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C159 and C160	Ceramic high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C161#	Deleted by Rev. S.	
C162	Ceramic, temp compensating, insulated, tubular; 7.0 uuf ±0.5 uuf ±10%, 500 VDCW.	C-7770468-P7
C163#	Deleted by Rev. S.	
C164#	Deleted by Rev. S.	
C165	Ceramic, temp compensating, insulated, tubular; 7.0 uuf ±0.5 uuf ±10%, 500 VDCW.	C-7770468-P7
C166#	Deleted by Rev. S.	
C167#	Variable, air, 12 or 13 plates, 3.2 mmfd min, 12 mmfd max, air gap 01039 to 0.045. Teleradio Cat. #T-9476. Added by Rev. F.	B-7491398-P1
C170	Ceramic, high K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C171	Uncased mica, 250 mmfd ± 10%, 500 v d-c w.	PL-7133474-G3
C173	Ceramic, Hi-K, 100 mmfd ± 20%, 500 v d-c w. Erie Style 331 Hi-K.	M-7483722-P1
C174	Mica, Class C: 330 mmfd ± 10%, 500 v d-c w. RETMA Type RCM20C331K.	P-3R141-P50
C175	Ceramic, Hi-K disk, 0.005 mfd +100% -0%, 500 v d-c w.	C-7774750-P11
C178	Paper, molded plastic, 0.01 mfd ± 20%, 400 v d-c w. Sprague Cat. #109P10304.	B-7491096-P27
C179	Ceramic, Hi-K, 100 mmfd ± 20%, 500 v d-c w. Erie Style 331 Hi-K.	M-7483722-P1
C182	Paper, molded plastic, 0.022 mfd ± 20%, 400 v d-c w. Sprague Cat. #109-P22304.	B-7491096-P29
C183	Paper, molded plastic, 0.10 mfd ± 20%, 400 v d-c w. Sprague Cat. #109P10404.	B-7491096-P33
C184	Ceramic, high K disk, 4700 mmfd ± 10%, 500 v d-c w. Radio Materials Corp. Type JL.	C-3R81-P472K
C187	Molded phenolic, 0.68 mmfd ± 0.068 mmfd, 500 v d-c w. Jeffers Type JM 5/32.	K-7130348-P10
C188# thru C190#	Added by Rev. H. Deleted by Rev. N.	
C191# thru C193#	Silver mica, dipped phenolic insulation; 330 mmfd ± 5%, 500 v d-c w. Added by Rev. N.	B-7489162-P39
C194#	Ceramic, temp compensating; 100 mmfd ± 10%, 350 v d-c w. -3300 temp coef. Added by Rev. Q.	B-7473485-P30
C195#	Ceramic, Hi-K disk; 0.1 mfd +80% -25%, 500 v d-c w. Sprague Cat. #36C190A. Added to 4ET21A2 and A12 by Rev. R.	B-7488160-P3
C196# thru C198#	Mechanical Assembly Includes the following: (2) Washers, steel. (G-E Dwg No. A-40315 93-P1). (2) Washers, nylon. (G-E Dwg No. A-4032 084-P1). (2) Insulators. (G-E Dwg No. A-4031594-P1) (1) Bracket, mounting for coils (G-E Dwg No. B-5491229-P1). (Added by Rev S).	
C201	Variable, air, 1.98 to 7.83 mmfd, 1250 v d-c peak. Johnson Cat. #160-104-43. Used in 4ET21A12 only.	M-7481115-P2
C202#	Deleted by Rev. G.	
C203# thru C205#	Ceramic high K disk, 0.0015 mfd +100% -0%, 500 v d-c w. Used in 4ET21A12 only. Added by Rev. B.	C-7774750-P5
C206#	Deleted in 4ET21A12 by Rev. Q.	
C207# and C208#	Ceramic, temp compensating, tubular; 7.0 mmfd ± 0.5 mmfd, 500 v d-c w. Added by Rev. R.	C-7770468-P7
C209#	Ceramic, temp compensating; 100 mmfd ± 10%, 350 v d-c w. -330C temp coef. Added to 4ET21A12 only by Rev. Q.	B-7473485-P30
C210# and C211#	Ceramic, Hi-K disk, insulated; 0.1 mfd +80% -30%, 50 v d-c w. Sprague Cat. #36C172. Added to 4ET21A12 only by Rev. R.	A-7161189-P2
	LAMP	
I101	Neon, 105-125 v circuit, 1/25 w, unbased wire terminal. G-E Cat. #NE-2.	A-7136227-P1
	JACKS	
J101 thru J105	Test point jacks, stake in molded nylon. Alden Products Type 110BC1-green.	A-7150763-P4
J106	Test point jack, stake in molded nylon. Alden Products Type 110BC1-red.	A-7150763-P2
J111 and J112	Phono type mica filled phenolic. Similar to Cinch Cat. #14M20190 except silver plated.	A-7104941-P7
	RELAYS	
K101#	Deleted by Rev. K.	
K102#	Nominal coil rating 4 to 7 v d-c, pickup 3.5 v or less at 25°C, dropout 2 v or less at 25°C resistance 20 ohms ± 8% at 25°C, 1 form B, 1 form C contact, 30 grams min pressure. Added by Rev. K.	B-7486116-P8
	INDUCTORS	
L101#	Deleted by Rev. D.	
L102	RF choke: inductance 765 uh ± 10%, max current 33 ma, resistance 17.5 ohms. National Type R-33.	A-7127925-P5
L103#	Deleted by Rev. B.	
L104	RF choke coil: inductance 1.8 uh, current 1000 ma, 75 to 190 mc freq range. Ohmite Cat #Z-144.	P-7772834-P5
L105#	Coil: 1-3/4 turns at 16 turns per inch, 0.625" ID of Formex. B22F1, 0.0641" dia. Changed by Rev. A.	A-7145857-P1
L106	Coil: 1-1/2 turns at 8 turns per inch, 0 687" ID of B11B10A5. 0.060" dia	A-7145856-P1
L108#	RF choke coil: inductance 39 uh ± 10%. Jeffers Cat #10203-40. Added by Rev. D.	B-7488079-P50
L109 and L110	RF choke coil: inductance 0.20 uh current 1000 ma. 320 to 320 mc freq range. Ohmite Cat. #Z-480.	P-7772834-P7
L112	RF choke coil: inductance 1.8 uh, current 1000 ma. 75 to 190 mc freq range. Ohmite Cat. #Z-144.	P-7772834-P5
L113#	Loop made of B11B10A5, 0.080" dia tinned copper wire. Changed by Rev. A.	A-7145622-P1
L114#	Deleted by Rev. F.	
L116#	Coil: 1 turn at 11 turns per inch. 0.687" ID of 0.064" dia. #14 Awg Insulated copper wire. Added by Rev. F.	A-7144943-P2
L124#	Deleted by Rev. S.	
L125#	Deleted by Rev. S.	
L126#	Deleted by Rev. S.	
L127#	R.F. Choke coil: inductance 100 uh ± 10%. Jeffers Cat. # 10404-34. Added by Rev. P.	B-7488079-P72
L203#	Deleted from 4ET21A12 by Rev. B.	
L204#	Coil: 2-turns, right hand wound. Added by Rev. S.	A-4031598-P1
L205#	Coil: 3-turns, right hand wound. Added by Rev. S.	A-4031595-P1
L206#	Coil: 2-turns, right hand wound. Added by Rev. S.	A-4031598-P2
	PLUG	
P101	Part of W101.	
	RESISTORS	
R101	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R102#	Composition, 470 ohms ± 10%, 1/2 w. Added by Rev. A.	C-3R77-P471K
R103	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3R77-P473K
R107	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R108	Composition, 3300 ohms ± 5%, 1/2 w.	C-3R77-P332J
R114	Composition, 0.33 megohm ± 10%, 1/2 w.	C-3R77-P334K
R115	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R116#	Deleted by Rev. A.	
R117#	Composition, 27,000 ohms ± 10%, 1/2 w. Added by Rev. A.	C-3R77-P273K
R120	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R121	Composition, 3900 ohms ± 10%, 1/2 w.	C-3R77-P392K
R123	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3R77-P473K
R127	Composition, 0.22 megohm ± 10%, 1/2 w.	C-3R77-P224K
R128	Composition, 8200 ohms ± 10%, 1/2 w.	C-3R77-P822K
R129	Composition, 560 ohms ± 10%, 1 w.	C-3R78-P561K
R130	Composition, 15,000 ohms ± 10%, 1 w.	C-3R78-P153K
R135	Composition, 15,000 ohms ± 10%, 1/2 w.	C-3R77-P153K
R137	Composition, 22,000 ohms ±10%, 2 w.	C-3R79-P223K
R141	Composition, 27,000 ohms ± 10%, 1/2 w.	C-3R77-P273K
R142	Wirewound, 16,000 ohms ± 5%, 10 w. Sprague Type 10 KT with pigtail leads.	M-7478740-P4
R144	Composition, 0.47 megohm ± 10%, 1 w.	C-3R78-P474K
R145	Composition, 27,000 ohms ± 5%, 1/2 w.	C-3R77-P273J
R146	Composition, 2000 ohms ± 5%, 1/2 w.	C-3R77-P202J
R147	Wirewound, precision, 5.0 ohms ± 2%, 2 w. Shallcross Type 220 RA.	K-7119855-P8
R165	Composition, 1.0 megohm ± 10%, 1/2 w.	C-3R77-P105K
R166	Composition, 470 ohms ± 10%, 1/2 w.	C-3R77-P471K
R167	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R168#	Deleted by Rev. M.	
R171	Composition, 2200 ohms ± 10%, 1/2 w.	C-3R77-P222K
R172 and R174	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R178	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3R77-P474K
R179	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R180	Composition, 0.22 megohm ± 10%, 1/2 w.	C-3R77-P224K
R181	Composition, 3900 ohms ± 10%, 1/2 w.	C-3R77-P392K
R182	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3R77-P473K
R183	Composition 3900 ohms ± 10%, 1/2 w.	C-3R77-P392K
R184	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3R77-P473K
R185#	Deleted by Rev. A.	
R186	Potentiometer, carbon film, 100,000 ohms ± 20%, 1/5 w. linear taper, 7/8" slotted shaft with locknut. Chicago Telephone and Supply Type 70	B-7487391-P101
R187#	Deleted by Rev. N.	
R188#	Deleted by Rev. E.	
R189	Composition, 1.0 megohm ± 10%, 1/2 w.	C-3R77-P105K
R190	Composition, 10.0 megohm ± 10%, 1/2 w.	C-3R77-P106K
R191#	Added by Rev. E. Deleted by Rev. H.	
R192#	Composition, 220 ohms ± 10%, 1/2 w. Added by Rev. R.	C-3R77-P221K
R193# thru R195#	Added by Rev. H. Deleted by Rev. N.	C-3R77-P273K
R196#	Composition; 0.18 megohm ± 10%, 1/2 w. Added by Rev. N.	C-3R77-P184K
R197# thru R199#	Composition; 15,000 ohms ± 10%, 1/2 w. Added by Rev. N.	C-3R77-P153K
R200	Composition, 39 ohms ± 10%, 2 w. (Two-frequency use only.)	C-3R79-P390K
R201	Composition, 0.10 megohm ± 10%, 1/2 w. (Two-frequency use only.)	C-3R77-P104K
R202#	Composition, 470 ohms ± 10%, 1/2 w. (Two-frequency use only.) Added by Rev. A.	C-3R77-P471K
R203# and R204#	Composition, 220 ohms ± 10%, 1/2 w. Added to 4ET21A12 only by Rev. R.	C-3R77-P221K
	SWITCH	
S101	Toggle type; spst. 3 amp. 250 v. Arrow Hart and Hegeman Cat. #20994-WD.	A-7145985-P1
	TUBES	
V101	Type 6661/6BH6.	
V102	Type 6678/6U8.	
V103	Type 6661/6BH6.	
V104	Type 6677/6CL6.	
V105#	Deleted by Rev. M.	
V106#	Type 2E26. Added by Rev. M.	
V107 and V108	Type 6146.	
V109 and V110	Type 6680/12AU7.	
V201	Type 6661/6BH6. (Two-frequency use only.)	
	CABLE	
W101	Cable assembly: 11-conductor cable with 11-pin male connector identified with a stamped or molded "T"	B-7489383-P1
	SOCKETS	
XV101	Tube socket: mica filled phenolic, 7 pin miniature, bottom mount flat top. 4 ground lugs.	P-7768887-P14
	SOCKETS (CONTINUED)	
XV103	Tube socket: mica filled phenolic, 7 pin miniature, bottom mount flat top, 4 ground lugs	P-7768887-P14
XV104	Tube socket: mica filled phenolic, 9 pin miniature, 4 ground lugs.	M-7480532-P8
XV105#	Deleted by Rev. M.	
XV106#	Tube socket: 8 pin. Added by Rev. M.	PL-7133702-G1
XV107	Tube socket: 8 pin.	PL-7133702-G3
XV108	Tube socket: 8 pin.	PL-7133702-G6
XV109 and XV110	Tube socket: mica filled phenolic, 9 pin miniature, 4 ground lugs.	M-7480532-P8
XV201	Tube socket: mica filled phenolic, 7 pin miniature, bottom mount flat top, 4 ground lugs (Two-frequency use only.)	P-7768887-P14
XY101#	Deleted by Rev. H.	
XY102#	Crystal socket and ring: octal, mica-filled yellow and black phenolic with 2 diametrically opposed keyways. Similar to Cinch Cat. #51E16871. Added by Rev. H.	A-7147225-P1
	CRYSTALS	
	When reordering, give G-E Drawing and Part No. and specify exact frequency of each crystal. Crystal frequency = operating frequency ± 24.	
Y101	One unheated crystal. One heated crystal. Crystal oven for use with heated crystal.	A-7147159-P1 A-7147159-P6 B-5490303-P1
Y201	One unheated crystal. One heated crystal. Crystal oven for use with heated crystal. Used in 4ET21A12 only.	A-7147159-P1 A-7147159-P6 B-5490303-P1
	TANKS	
Z101	Multiplier plate tank. Includes the following electrical components with Z101 prefix.	PL-7488349-G1
Z101-C1	Capacitor: ceramic disk, temp compensating; 47 mmfd ± 10%, 500 v d-c w.	C-7774846-P17
Z101-C2	Capacitor: ceramic high K disk: 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
Z101-R1	Resistor: composition, 1000 ohms ± 10%, 1/2 w.	C-3R77-P102K
Z102	Multiplier plate tank. Includes the following electrical components with Z102 prefix.	PL-7486429-G1
Z102-R1	Resistor: composition, 1000 ohms ± 10%, 1/2 w.	C-3R77-P102K
Z103	Multiplier grid tank. Includes the following electrical components with Z103 prefix.	PL-7486428-G2
Z103-C1	Capacitor: ceramic disk, temp compensating: 100 mmfd ± 10%, 500 v d-c w.	C-7774846-P21
Z103-R1	Resistor: composition, 68,000 ohms ± 10%, 1/2 w.	C-3R77-683K
Z104	Multiplier plate tank. Includes the following electrical components with Z104 prefix.	PL-7486434-G1
Z104-R1	Resistor: composition, 470 ohms ± 10%, 1 w.	C-3R78-P471K
Z105	Multiplier grid tank. Includes the following electrical components with Z105 prefix.	PL-7486433-G1
Z105-C1	Capacitor: ceramic disk, temp compensating; 100 mmfd ± 10%, 500 v d-c w.	C-7774846-P21
Z105-R1	Composition, 27,000 ohms ± 10%, 1/2 w.	C-3R77-P273K
Z105-R2	Composition, 0.33 megohm ± 10%, 1/2 w.	C-3R77-P334K

PRODUCTION CHANGE SHEET
FOR
RECEIVER MODELS 4ER25C1,2,11 & 12, REV. G
RECEIVER MODELS 4ER25D1,2,11 & 12, REV. G

Changes listed below are identified by the letter appearing in the REV pad.

REV. A - Changed the frequency range of Receiver Models 4ER25C1 & 11, 4ER25D1 & 11 from 144-152 MC to 144-150.8 MC and Receiver Models 4ER25C2 & 12, 4ER25D2 & 12 from 152-174 MC to 150.8-174 MC.

Part Changed	Was	Changed To
C371	Capacitor: ceramic, Hi-K, 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048. G-E Dwg. No. B-7488160-P1.	Deleted.
C386	Added.	Capacitor: ceramic disk, insulated, 6000 mmfd ± 20%, 500 v d-c w. RMC Corp. Type JF discap G-E Dwg. No. B-5494481-P19.
C400	Capacitor: ceramic disk, insulated, 3000 mmfd ± 20% 500 v d-c w. RMC Corp. Type JF Discap G-E Dwg. No. B-5494481-P15.	Capacitor: ceramic disk, insulated, 6000 mmfd ± 20%, 500 v d-c w. RMC Corp. Type JF Discap G-E Dwg. No. B-5494481-P19.
T301	Transformer: Antenna includes the following electrical components with T301 prefix. G-E Dwg. No. PL-7144650-G1.	Deleted.

REV. A (Continued)

Part Changed	Was	Changed To
T322	Transformer: Antenna includes the following electrical components with T322 prefix. G-E Dwg. No. PL-7144650-G2.	Deleted.
T301-C1 and T322-C1	Capacitor: variable air, 1.98 to 7.83 mmfd, 1250 volts peak. EF Johnson Part #160-104-43. G-E Dwg. No. M-7481115-P2.	Deleted.
T301-C2 and T322-C2	Capacitor: ceramic, temp compensating, tubular, 10 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef. G-E Dwg. No. P-7770468-P241.	Deleted.
T301-C3 and T322-C3	Capacitor: variable air 1.98 to 7.83 mmfd, 1250 volts peak. EF Johnson Part #160-104-43. G-E Dwg. No. M-7481115-P2.	Deleted.
T301-C4 and T322-C4	Capacitor: temp compensating, tubular, 6.0 mmfd ± 0.25 mmfd, 500 v d-c w. -80 temp coef. G-E Dwg. No. P-7770466-P237.	Deleted.
T301-C5 and T322-C5	Capacitor: ceramic temp compensating, 6.0 mmfd ± 0.25 mmfd, 500 v d-c w. -80 temp coef. G-E Dwg. No. B-7488184-P5.	Deleted.

REV. A (Continued)

Part Changed	Was	Changed To
T301-J1 and T322-J1	Connector: phono type, mica filled phenolic. Similar to Cinch Cat. #14H20190 except silver plated. G-E Dwg. No. K-7104941-P7.	Deleted.
T301-L1,L2 and T322-L1,L2	Coil: 6.5 turns per inch, right hand wound, 0.47 inches ID ± 0.01 inches G-E Dwg. No. A-7145404-P1.	Deleted.
T336	Added.	Transformer: Antenna, includes the following electrical components with T336 prefix. G-E Dwg. No. PL-7144650-G3.
T336-C2	Added.	Capacitor: ceramic, temp compensating, tubular, 10 mmfd ± 0.25 mmfd, 500 v d-c w. -80 temp coef. G-E Dwg. No. P-7770468-P241.
T336-C4	Added.	Capacitor: temp compensating, tubular, 6.0 mmfd ± 0.25 mmfd, 500 v d-c w. -80 temp coef. G-E Dwg. No. P-7770466-P237.
T336-C5	Added.	Capacitor: ceramic, temp compensating, 6.0 mmfd ± 0.25 mmfd, 500 v d-c w. -80 temp coef. G-E Dwg. No. B-7488184-P5.
T336-C8 and T336-C9	Added.	Capacitor: variable, air 2.13 to 8.73 mmfd, 1250 volts peak. G-E Dwg. No.M-7481115-P13.

REV. A (Continued)

Part Changed	Was	Changed To
T336-J1	Added.	Connector: phono type, mica filled phenolic. Similar to Cinch Cat. #14H20190 except silver plated. G-E Dwg.No. K-7104941-P7.
T336-L1 and T336-L2		Coil: 6.5 turns per inch, right hand wound, 0.47 inches ID ± 0.01 inches G-E Dwg. No. A-7145404-P1.
T337	Added.	Transformer: Antenna, includes the following electrical components with T301 prefix. G-E Dwg. No. PL-7144650-G4.
T337-C5	Added.	Capacitor: ceramic, temp compensating, 6.0 mmfd ± 0.25 mmfd, 500 v d-c w. -80 temp coef. G-E Dwg. No. B-7488184-P5.
T337-C6	Added.	Capacitor: ceramic, temp compensating; 14.0 mmfd ± 5%, 500 v d-c w. Erie Type 331. G-E Dwg. No. M-7473485-P14.
T337-C7	Added.	Capacitor: ceramic, temp compensating, tubular, 10 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef. G-E Dwg. No. P-7770468-P241.
T337-C8 and T337-C9	Added.	Capacitor: variable, air 2.13 to 8.73 mmfd, 1250 volts peak. G-E Dwg. No. M-7481115-P13.

REV. A (Continued)

Part Changed	Was	Changed To
T337-J1	Added.	Connector: phono type, mica filled phenolic. Similar to Cinch Cat. #14H20190 except silver plated. G-E Dwg.No.K-7104941-P7.

Elementary Diagram, Service Outline, Block Diagram and Text Changes

T301* Changed to read T336*
T332 changed to read T337
T301-C1, 1.8-8.7 changed to read T336-C8, 2.0-9.0
T301-C3, 1.8-8.7 changed to read T336-C9, 2.0-9.0
C400, 3000 changed to read C400, .006 mfd.
C371, 0.01 mfd changed to read C386, .006 mfd.
144-152 MC changed to read 144-150.8 MC
152-174 MC changed to read 150.8-174 MC
Y301 crystal frequency ranges 11.275-11.942 MC (4ER25C&D1,11) and 11.942-13.775 MC (4ER25C&D2,12) changed to read 11.275-11.842 (4ER25C&D1,11) and 11.842-13.775 MC.

REV. B - Lowered residual noise under squelch conditions and increased the spurious response attenuation.

Part Changed	Was	Changed To
R343	Resistor: composition, 47,000 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P473K.	Replaced by R408.
R408	Added in place of R343.	Resistor: composition, 0.22 megohm ± 10%, 1/2 w. G-E Part No. C-3R77-P224K.
C411	Added.	Capacitor: ceramic, Hi-K disk, 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145. G-E Dwg. No. B-7488160-P2.

REV. B (Continued)

Part Changed	Was	Changed To
C412 and C413	Added.	Capacitor: ceramic disk, insulated, 6000 mmfd ± 20%, 500 v d-c w. RMC Corp. Type JF Discap. G-E Dwg. No. B-5494481-P19.

Elementary Diagram Changes

R343, 47 K was replaced by R408, 220 K.
C411, .02 MF was added between XV311-7 and XV311-5.
C412, .006 MF was added between XV302-4 and XV302-5.
C413, .006 MF was added between XV304-4 and XV304-9.

REV. C - Mechanical Simplication

Part Changed	Was	Changed To
C339	Capacitor: ceramic, Hi-K disk, 0.02 mfd +100% -0%, 500 v d-c w. G-E Dwg. No. C-7774750-P15.	Deleted.
C394	Capacitor: ceramic, Hi-K disk, 0.02 mfd, +80% -20%, 450 v d-c w. Centralab Type DA-145. G-E Dwg. No.P-7488160-P2.	Deleted.
C414	Added in place of C339 and C394.	Capacitor: Mylar-dielectric, 0.047 mfd, ± 20%, 50 v d-c w. Similar to Goodall Type 601 PE. G-E Dwg. No. B-5491189-P4.

Elementary Diagram Changes

C339, .02 MF and C394, .02 MF were replaced by C414, .047 MF.

REV. D - Allows operation of squelch in the center of squelch control.

Part Changed	Was	Changed To
R344	Resistor: composition; 24,000 ohms ± 5%, 1/2 w. G-E Part No. C-3R77-P243J.	Replaced by R412.
R412	Added in place of R344.	Resistor: composition; 20,000 ohms ± 5%, 1/2 w. G-E Part No. C-3R77-P203J.

Elementary Diagram Changes

R344, 24K was replaced by R412, 20K.

REV. E - Raises maximum squelch sensitivity.

Part Changed	Was	Changed To
R412	Resistor: composition; 20,000 ohms ± 5%, 1/2 w. G-E Part No. C-3R77-P203J.	Resistor: composition; 27,000 ohms ± 5%, 1/2 w. G-E Part No. C-3R77-P273J.

Elementary Diagram Changes

Changed R412, 20K to R412, 27K.

REV. F - Provides greater squelch rotation between open and critical squelch.

Part Changed	Was	Changed To
R340	Resistor; composition, 0.39 megohms ± 10%, 1/2 w. G-E Part No. C-3R77-P394K.	Replaced by R415.
R415	Added in place of R340.	Resistor: composition, 0.27 megohms ± 10%, 1/2 w. G-E Part No. C-3R77-P374K.

REV. G - To improve clipping characteristics.

Part Changed	Was	Changed To
R355 and R408	Resistor: composition, 0.22 megohm ± 10%, 1/2 w. G-E Part No. C-3R77-P224K.	Deleted.
R412	Resistor; composition 27,000 ohms, ± 5%, 1/2 w. G-E Part No. C-3R77-P273J.	Resistor: composition 24,000 ohms ± 5%, 1/2 w. G-E Part No. C-3R77-P243J.
R419	Added.	Resistor: composition 47,000 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P473K.
R420	Added.	Resistor: composition, 68,000 ohms ± 10%, 1/2 w. G-E Part No. C-3R77-P683K.
R421	Added.	Resistor: composition, 0.15 megohm ± 10%, 1/2 w. G-E Part No. C-3R77-P154K.
C424	Added.	Capacitor: ceramic Hi-K disk, 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145. G-E Dwg. No. B-7488160-P2.

REV. G (Continued)

Elementary Diagram Changes

R408, 220K was changed to read R419, 47K
R412, 27K was changed to read R412, 24K

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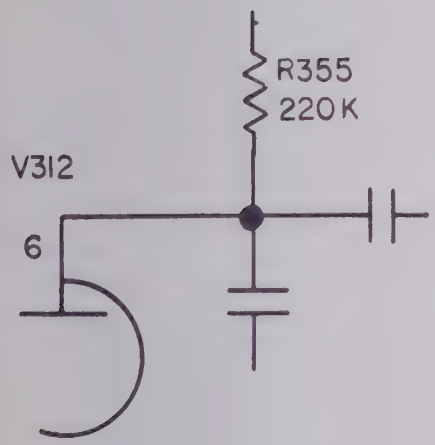

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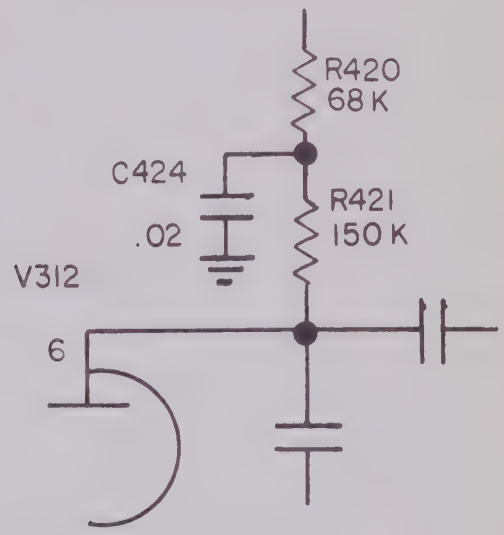


OGRESS LINE

COMMUNICATION EQUIPMENT

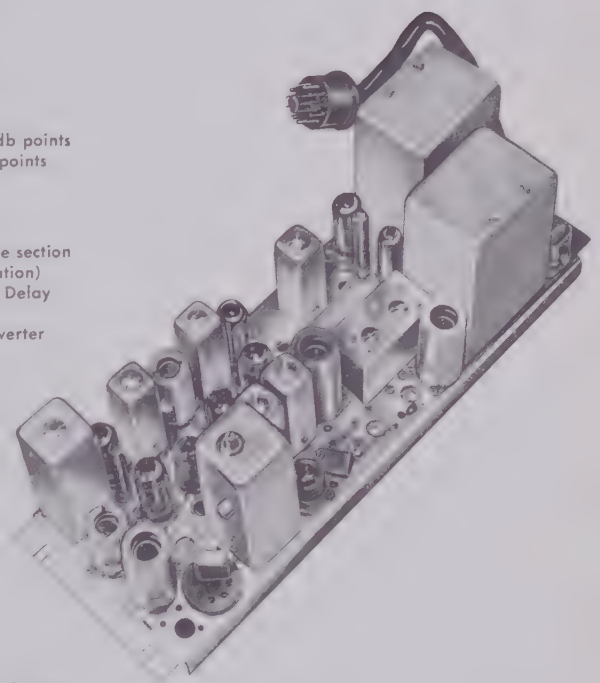
SPECIFICATIONS

CHASSIS R-3

Type	ER-25-C: Narrow band receiver for station or mobile use ER-25-D: Wide band receiver for station or mobile use
Frequency range	NARROW BAND: Model No. 4ER25C2 — 150.8-174 megacycles WIDE BAND: Model No. 4ER25D1 — 144-152 megacycles Model No. 4ER25D2 — 150.8-174 megacycles
Audio output	1.5 watts with less than 10% distortion
Sensitivity	0.5 uv (20 db quieting method)
Squelch	Adjustable, will open at less than 0.25 uv at critical setting
Selectivity:	
(EIA method) **20 db quieting method***	NARROW BAND: 30 kc channels Adjacent channel 80 db down 100 db ±25 kc
EIA method **20 db quieting method***	WIDE BAND: 60 kc channels Adjacent channel 85 db down 100 db ±40 kc
nd width by swing method of measurement	NARROW BAND: ±6 kc at the 6 db points WIDE BAND: ±15 kc at the 6 db points
Spurious responses	At least 100 db down

Tube complement

6AK5	RF Amplifier
6679/12AT7	1st Oscillator (2nd triode section for two-frequency operation)
6679/12AT7	1st Converter and AGC Delay
6679/12AT7	3x and 4x Multiplier
6679/12AT7	2nd Oscillator and Converter
6661/6BH6	High–IF Amplifier
6661/6BH6	Low–IF Amplifier
6661/6BH6	Low–IF Amplifier
6661/6BH6	1st Limiter
6661/6BH6	2nd Limiter
6663/6AL5	Discriminator
6663/6AL5	Noise Rectifier
6661/6BH6	Noise Amplifier
6681/12AX7	Audio Amplifier
6669/6AQ5	Audio Output



Ambient temperature	−30°C to +60°C
ency stability over specified temperature range	Unheated crystal: ±0.002% Heated crystal: ±0.0005%
dio frequency characteristics (EIA method)	Within +2 db to −8 db of a 6 db/octave de-emphasis from 300 to 3000 cps. 1000 cps. reference
Maximum recommended frequency spread in 3 or 4 channel operation	0.4% of operating frequency (approximately 600 kc)
Size	13½" long x 4½" wide x 5¾" high
Weight	5 lbs.

*This figure included for comparison purposes only since this method is obsolete.

COPE OF SPECIFICATIONS—In the construction of the equipment described herein, the full intent of the specification will e met. It is assumed, however, that any departure from the specification, desirable for reasons of improved design or operation, ill be permissible.

he equipment described above meets or exceeds all applicable EIA specifications.

GENERAL ELECTRIC

COMMUNICATION PRODUCTS DEPARTMENT

MOUNTAIN VIEW ROAD • LYNCHBURG, VA.

S.A.

5y ECR-240G

DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR RECEIVER MODELS 4ER25C1, 2, 11 & 12 AND 4ER25D1, 2, 11 & 12

General Electric FM Radio Receivers described here-in are Progress Line equipment, designed for operation on fixed frequencies within the 144 to 174 megacycle range of frequencies. These receivers have been assembled on 4-1/2 inch x 13-1/2 inch block chassis which mount directly to the framework of a mobile unit assembly, or to the chassis of a rack mounted power supply for a-c application. Operating voltages of 200 volts (nominal B+) and 6.2 volts or 13.2 volts (nominal "A") are derived from a power supply external to the receiver, thus permitting fixed/mobile versatility in two-way land mobile communication services. The external control and power terminations are made through an 11-conductor cable and plug which mate with a socket from the power supply chassis. Tuning controls, except for one multiplier adjustment, one antenna transformer adjustment, and the discriminator primary, are accessible from the top of the receiver chassis.

These receivers employ a double-conversion superheterodyne circuit with automatic gain control on the RF Amplifier and 14 tuned circuits in the IF stages. A dual tuned pre-selector provides maximum protection to the first stage against strong, undesired signals. Multiple-channel operation with as many as four frequencies is obtainable by the employment of options. The 17-inch case assembly is required for three and four frequency receiver mobile options.

APPLICATIONS

The receivers covered by these instructions may be used interchangeably between mobile and station installations when used with the correct power supply. No change or modification will be required in the receiver when transferring the unit from service to service, since changes in "A" voltages are taken care of in connections to the power supply.

TUBES

The tubes employed in the circuits of this receiver are widely accepted, highly efficient, long-life tubes and meet the requirements of the majority of installations. Communi-

cation type tubes are pre-tested tubes selected specifically to meet the requirements of two-way application. They are tested for heater cycling reliability, operation at ± 20% of filament ratings and stabilized for a predetermined period of time. As these tubes become available, they are being employed in this receiver and directly replace the standard tube types.

In certain mobile applications, where heavy shock and vibration are regularly encountered, a still more rugged tube, the G-E Five Star tube, may prove more economical. Five Star tubes are more ruggedly constructed, must pass more rigid tests, and are carefully "aged" before packaging. This results in greatly increased life, particularly under the severe vibration condition sometimes encountered in mobile installations. The Communication Type tubes and "Five-Star" tubes which are available for use in this receiver are listed below. Check with your tube supplier regarding the availability of those tubes marked with an asterisk.

Prototype Tube Type	Communication Tube Type	Five-Star Tube Type
6AK5		GL5654
6AL5	6663	GL5726
6AQ5	6669	GL6005
6BH6	6661	GL6265
12AT7	6679	GL6201
12AX7	6681	GL5751

Five-Star tubes are directly interchangeable for 6- or 12-volt operation. In 12-volt applications the heater voltages should be checked at both heater buses (brown wire and orange wire), since the GL5751 and the GL6265 require 0.175 ampere heater current per section; whereas their prototypes required 0.150 ampere. The extent of unbalance in the heater circuit depends on the number of tubes replaced and the location of Five-Star tubes used in the transmitter and receiver. A resistor may be added if required to keep the heaters balanced within this rating. The transmitter heaters must also be considered when checking the filament balance on 12-volt operation.

MAINTENANCE

Inspecting the receiver regularly will assure peak performance and lengthen the life of the equipment. In this way trouble may be anticipated and corrected before operational difficulties arise.

TEST EQUIPMENT

1. A 20,000 ohm-per-volt voltmeter with a 0-3 volt scale.

2. A 1000 ohm-per-volt A.C. voltmeter (Station Application only).

PROCEDURE

1. The first and most important reading is that of the 2nd limiter on noise. This reading when taken on the 0-3 volt scale of a 20,000 ohm-per-volt meter connected between J303 and ground should not fall below 0.9 volts. If this value is exceeded, it is likely that the receiver is in good operating condition. If not, the trouble may be in the antenna or input circuits.

2. The 1st Oscillator grid metering voltage, as read on the 0-3 volt scale of a 20,000 ohm-per-volt meter connected between J305 and ground will be approximately 1.5 volts (when 1st Oscillator plate tank is correctly tuned). If this voltage drops below 1.2 volts (plate tank correctly tuned), replace the 1st oscillator tube, V314.

3. Meter the receiver filament voltage at the power supply. When the source voltage is within proper limits, the filament voltage should fall within ± 10% of the values given below.

Application	Meter Connected Between	Nominal Reading on 0-3 V Scale of 20,000 ohm/volt meter	Corrected Meter Reading or A-C Meter Reading
6 volt Mobile	Imp.V (J506 and GND (J508)	0.98 volts d-c	5.9 volts d-c
12 volt Mobile	Imp.V (J506 and J508)	2.1 volts d-c	12.9 volts d-c
117 volt Station	J510-6 and J510-7		6.3 volts a-c

4. Meter the Receiver B-plus at the power supply. When the source voltage is within proper limits the Receiver B-plus voltage should fall within ± 10% of the values given below.

Application	Measured Between	Reading on 0-3 volt Scale of 20,000 ohm/ volt meter	Corrected Meter Reading
6 & 12 V Mobile	LB+ (J505) and GND (J508)	2.0 volts	200 volts
117 Volt Station		2.0 volts	200 volts

5. If all metering voltages are within tolerance and the Second Limiter noise current is out of tolerance, replace the tubes in the multipliers and RF amplifiers. If tube replacement does not return the Second Limiter current to their nominal limits, check the front end tuning as described in Bench Alignment Procedures.

CIRCUIT ANALYSIS

Receiver Type ER-25-C and ER-25-D employs a double-conversion superheterodyne circuit with Automatic Gain Control on the first RF amplifier. RF selectivity is accomplished ahead of the RF stage.

RF signals received on the antenna are fed to the first RF grid through a double tuned pre-selector transformer circuit (T336). This circuit correctly terminates the 50 ohm transmission line and extracts maximum input power from the antenna system. It also steps up the input voltage as RF is transferred from the antenna to the 1st grid. Since the double tuned circuits of the pre-selector are very high in Q factor, and very selective, accurate tuning to the desired signal is required. The first RF Amplifier tube is coupled to the grid of the 1st Converter (1/2 12AT7 low noise triode) by a double tuned high Q RF transformer. A high IF frequency of 8.7 megacycles is derived by injecting the necessary oscillator voltage to the grid of the 1st Converter.

Injection voltage originates from the first crystal frequency which is multiplied in the 12AT7 (V315) 12 times before injection at the converter. The crystal oscillator (Channel A) utilizes 1/2 of a 12AT7 (V314) and a tuned tank circuit Z301, in a Miller oscillator circuit. For two frequency applications, the second

section of a V314 (1/2 12AT7) is utilized as the channel B crystal oscillator. Trimmer C352, across the crystal, makes it possible to shift the frequency of the crystal oscillator slightly so as to adjust it to the systems channel frequency. This method of shifting the crystal frequency eliminates the necessity of heated ovens for crystals in equipment exposed to the range of ambient temperatures normally encountered in land mobile services, since the basic temperature stability of the crystal is not impaired or affected. The Multiplier plate circuit transformers T310 and 311 are double tuned high Q transformers which adequately dispose of unwanted frequencies from the crystal multiplier. The second section of the 12AT7 (V315) multiplies the crystal frequency by 3, while the first section quadruples its input -- thus effecting a 1 x 12 multiplier before injection to the first Converter. The first section of the 12AT7 1st Converter (V302) is used as a delay diode on the Automatic Gain Control voltage, derived from the 1st Limiter grid and applied to the control grid of the 6AK5 RF Amplifier (V301). The amount of delay voltage is adjusted so that no AGC voltage is present on the RF Amplifier grid for relatively weak input signals.

The 8.7 megacycle high IF signal derived from the 1st Converter is fed through a four-circuit IF transformer (T334) to the second converter. This arrangement of four tuned circuits, between the two converter stages gives maximum protection against receiver desensitization. All of the couplings in the transformer are set at critical and can, therefore, be peaked by observing the first limiter current while a weak input signal is used at the input of the receiver. The output of the selective 8.7 megacycle high IF amplifier stage is fed to the grid of the second converter (V304-1/2 12AT7), mixed with the 2nd oscillator injection frequency of 8410 kilocycles producing a 290 kilocycle beat frequency or low IF frequency.

One six and one double tuned IF transformer produces the selectivity required for adjacent channel operation, while permitting full modulation acceptance on weak signals. The first low IF transformer consists of six resonant circuits, alternately inductive and capacitively coupled to each other. The coupling may be easily reduced to yield the proper selectivity for narrow band operation. The output signal of the 2nd low IF Amplifier is fed through the double tuned IF transformer in its plate circuit to the grid of a 6BH6 1st limiter (V307).

The 1st and 2nd limiter tubes (V307 and V308) are coupled by L306 and L307, whereby sufficient gain for good limiting action is provided. The output of the 2nd limiter goes directly to the discriminator where the audio voltages are recovered from the FM signal.

The rectified output of the Foster-Seely type discriminator serves two or three purposes: The audio portion of the signal is fed to the 6AQ5 Audio Amplifier through a de-emphasis network composed of R335, C333, R333, R336, C335 and R337. A rheostat volume control, external to the receiver chassis, is introduced in the circuit at the junction of R337 and C336.

Under no carrier conditions, noise, a good portion of which may be due to shot effect and thermal agitation in the first stages of the receiver, is amplified and would ordinarily appear at the loudspeaker as audio noise. To eliminate this, a squelch circuit is introduced. To understand the operation of the squelch circuit, assume no signal is received. The higher frequency components of the noise (above voice frequency range) introduced are coupled to the grid of the noise amplifier. The noise signal is amplified and applied to the noise rectifier, which is a voltag doubler. The rectified noise voltage is divided by a resistor network, and a portion of the voltage developed is applied to the control grid of the squelch tube (V312-2), driving the grid positive with respect to the cathode. This causes plate current to flow, which, in turn, causes a larger drop across the plate resistor. Since this resistor is connected to the grid of the Audio Amplifier, the audio amplifier is biased negatively until no plate current flows. Thus, no amplification of the noise takes place and the output does not appear at the loudspeaker.

When a signal is received, the limiters become saturated, noise no longer reaches the discriminator or noise amplifiers, and the positive voltage on the grid of the squelch amplifier disappears. Negative voltage (with respect to ground) from the 2nd limiter is introduced into the noise rectifier circuit, effecting a negative potential at the grid of the squelch amplifier control grid and thus cutting the tube off and allowing the bias voltage of the first audio tube to return to normal.

Audio voltages from the transmitter signal are effectively blocked from the noise amplifier due to the capacitors selected. These capacitors which couple the noise signal to the noise amplifier grid and then to the noise rectifier, are of small values which discriminate against the low audio frequencies so that the audio signal is not amplified or rectified to any appreciable extent by the noise amplifier.

Adjustment of the squelch circuit, in order to allow the smallest possible audio signal to render the receiver operative, may be made by a squelch control which is located external to the receiver chassis. This control consists of a rheostat electrically tied to the cathode circuit of the noise amplifier, which varies the gain of the tube by varying its bias.

In operating the equipment, it will be noticed that the squelch does not close immediately when the carrier goes off the air at the end of transmission. If the unit is in a noisy area, a short "burst" of noise will be heard in the loudspeaker at the end of a transmission. The duration of noise is determined by the time constant established by capacitors C345, C346 and resistor R345. If desired, the duration of the noise signal that breaks through can be shortened considerably by removing capacitor C345. It must be remembered, however, that if this time constant is reduced, the weak signals found in the fringe area will be harder to understand since the squelch circuit will react very quickly to variations in signal strength. If the unit is to work in an area where the signals are always strong, the time constant can be reduced with no appreciable effect on intelligibility or operation of the receiver.

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

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Item 6

ADDENDUM
TO
EBI-41680

The 4ER25DA2 Receiver furnished under this requisition has been modified as outlined below. Refer to Elementary Diagram DD-5497070.

1. A 680K resistor has been wired in parallel with R307, in the plate supply of the first converter (V302).

2. One end of Cable W2315 (single-lead cable from Receiver Front-End Assembly, PL-7150710-G1) is soldered to XV302-6. This lead connects the output of the Front-End Unit to the receiver first converter. Refer to Dwg. D-7665394 in EBI-41242).

3. One end of the single-lead cable, W2316 (also from the receiver Front-End Unit) is soldered to TB16-1 in the receiver AGC circuit.

4. Tone Compensating Network, PL-7150715-G6, is installed in the receiver to provide for matching the discriminator output to a cathode follower circuit. Refer to EBI-41780.

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

BENCH ALIGNMENT PROCEDURE FOR RECEIVER MODELS 4ER25C1,2,11,12 AND 4ER25D1,2,11,12

GENERAL

The following instructions cover the procedure for completely aligning the Receiver. Whenever a stage has been tampered with, misaligned or modified, etc., follow the procedure outlined in this instruction. Instructions are also provided at the end of this instruction for converting wide-band Receiver Type ER-25-D for narrow-band operation.

ALIGNMENT USING SERVICE OUTLINE

The Simplified Alignment Procedure found in the Service Outline for the Receiver may be used if only the oscillator, multiplier, limiter or the secondary of the discriminator need retuning.

METHODS OF BENCH ALIGNMENT

Most of the stages in this receiver are designed for either loose or critical coupling and can be tuned by simple peaking methods. The 1st and 2nd IF's (T324 or T318, and T335) are overcoupled and must be tuned by the resistor loading method (best) or the peak and dip method.

1. Peaking Method:

An RF signal of the proper frequency is fed to a loosely or critically coupled stage and the stage is then adjusted for maximum meter reading at its output.

2. Discriminator Adjustment Method:

An unmodulated RF signal of the proper frequency (i.e., 290-kc) ± 10-kc is applied to the discriminator stage. The signal source should be of a constant amplitude over this ± 10-kc deviation. The primary tuning slug (bottom of transformer) is adjusted to obtain equal plus and minus voltages for ± 10-kc deviation. At -10 kc the voltage is negative and at +10 kc the voltage is positive.

3. Resistor Loading Method:

An RF signal of the proper frequency is fed to an overcoupled stage. Placing the proper load resistors across the coils makes the coils critically coupled, so that they can be tuned by a simple peaking procedure. After peaking, the resistor loads are removed, returning the coils to normal (overcoupled).

4. Peak and Dip Method:

An RF signal of the proper frequency is fed to an overcoupled stage. The first coil is adjusted for maximum, while the second coil is shorted out. The short is removed and then placed on the third coil, while the second coil is tuned for minimum. The remaining coils are also shorted and alternately peaked and dipped. The metering is done across the first coil during the entire procedure.

PRELIMINARY OPERATIONS

Warmup

The receiver should be allowed to warm up for 5 minutes or more before tuning.

The signal generator may require as much as a half hour for warmup. See individual signal generator manual for recommended warmup.

Voltage

Check for proper battery or supply voltage (6.6, 13.2 or 26.4 volts d-c or 117 volts a-c).

Discriminator Zero

During the entire alignment, the generator frequency must be checked every few minutes for zero discriminator (after the discriminator has been correctly set at 290-kc). The 290-kc signal should just saturate the second limiter grid. The 290-kc signal can be inserted at any stage ahead of the stage being tuned.

Crystal oven cycling, causing a slight frequency variation with temperature (.0005% of crystal frequency), can be observed when setting the discriminator for zero. This same crystal oven cycling is also present on the transmitter. When setting for discriminator zero, this cycling can be taken into account by first observing the maximum meter variation and then setting zero for an average of this variation.

Signal Generator Connections

Signals from the signal generator should be applied through a .01-mfd capacitor for all the procedures except when applying the signal to the antenna jack. The leads from the capacitor should be as short as possible. Connect the generator ground probe as close to the point of signal input as possible.

Metering

Before using a 20,000 ohm-per-volt meter or VTVM for metering, make certain that the meter reads exactly zero for the position it is being used. Since adjustments are to be made within 1-4 microamperes of zero, it is very important that zero is accurately set.

RECEIVER SENSITIVITY

Noise Current

The 2nd Limiter noise current was 110 microamperes or more when shipped. No loss of receiver sensitivity will occur as tubes age, until the noise current drops below 60% at J303 (2nd Limiter grid). To check for normal gain, make certain that the antenna transformer and RF tanks are both peaked. Replace the antenna with a 50-ohm load resistor. A reading of 100-microamperes or more at the 2nd Limiter grid will indicate normal gain.

Stage Gains

As a means of checking stage gains, the signal levels given in Table 1 may be used. When applied at the points indicated, these signal levels will give a reading of 40 microamperes at the LIM-1 jack. A variation in readings greater than 2-to-1, indicates a possible source of trouble. High noise current in a set may interfere with proper measurement of the first three figures in this table, in which case, both the input and 1st Limiter current may be doubled or tripled to estimate performance. An input of 25,000 microvolts at the 1st Limiter grid will produce a reading of 40 microamperes at the LIM-2 jack.

TABLE 1

SIGNAL INPUT TO OBTAIN READING OF 40 MICROAMPS AT LIM-1 JACK

SIGNAL GENERATOR FREQUENCY	SIGNAL LEVEL IN MICROVOLTS (Approx.)	INPUT POINT
Receiver Frequency	4	RF grid (XV301-1)
8.70 Mc	35	1st Mixer grid (XV302-7).
290-Kc	60	2nd Mixer grid (XV304-2).
290-Kc	300	XV305-1
290-Kc	50,000	XV306-1

DISCRIMINATOR ALIGNMENT

EQUIPMENT REQUIRED

1. A non-metallic screwdriver.

2. A 0-3 volt d-c meter. (20,000 ohm-per-volt or VTVM) or a 0-100 microampere d-c meter (EX-1-C).

3. A 290-kc calibrated signal source. (Generator can be calibrated against the 290-kc signal present in another receiver which has not been tampered with).

PROCEDURE

1. Apply 290-kc ± .002% signal through .01-mfd capacitor to XV307-1. Use a signal strong enough to saturate the 2nd LIMiter grid.

2. Connect voltmeter between DISC jack (J304-orange) and ground.

3. Remove 8410-kc crystal (Y302) to prevent signals or noise from interfering with alignment.

4. Tune top slug (secondary) of discriminator transformer (T308) for zero reading on voltmeter.

5. Turn signal generator dial to 280-kc and note value of negative voltage on meter.

6. Turn signal generator dial to 300-kc and note value of positive voltage on meter.

7. Positive and negative voltages noted in steps 4 and 5 must be equal in amplitude. If not equal, tune bottom slug (primary) of discriminator transformer (T308) until the voltages are equally positive and negative within 0.3-volt on a VTVM or 0.1-volt on a 0-3 voltmeter. Adjusting the primary slug will require that the secondary be readjusted.

IF ALIGNMENT

8.7-MC IF TRANSFORMER (T334)

Equipment Required:

1. A non-metallic screwdriver.

2. A 0-3 volt d-c meter or a 0-100 microampere d-c meter.

3. An 8.7-MC signal source.

Procedure:

1. Apply an 8.7-Mc signal through a .01-mfd capacitor to XV302-7. Do not saturate the 1st Limiter. Keep signal zeroed to discriminator (Remove the 1st Osc. crystal).

2. Connect meter between LIM-1 jack (J302-green) and ground.

3. Leave the 8410-kc crystal (Y302) in its socket.

4. Tune the four coils of the transformer for maximum meter reading.

Discriminator Idling:

When a set has been completely and properly aligned, the no-signal reading of the discriminator (noise only) should be within ± 0.6-volt of zero when read on a VTVM. This is equivalent to 10.0-microamperes on a 2400-ohm microammeter or 0.2-volt on a 20,000-ohm-per-volt meter. Whenever a receiver has been phase tuned (see section on Phase Tuning), the discriminator idling is determined by the phase tuning adjustment. For a properly aligned receiver, the discriminator idling should not exceed 0.6 to 0.9 volt, as read on a VTVM.

290-KC IF TRANSFORMER (T335)

Equipment Required:

1. A non-metallic screwdriver.

2. A 0-100 microampere d-c meter (G-E Type EX-1-C).

3. A 290-kc calibrated signal source.

Procedure:

1. Apply a 290-kc signal through a .01-mfd capacitor to XV305-1.

2. Connect meter between LIM-1 jack (J309-green) and ground.

3. Remove 8410-kc crystal (Y302) to prevent signals or noise from interfering with alignment.

4. Load the primary by soldering a 39,000-ohm, 1/2-watt resistor across the transformer leads.

5. Tune the secondary of the transformer for maximum reading at the LIM-1 jack.

6. Load the secondary by soldering a 22,000-ohm, 1/2-watt resistor across the transformer leads. Do not remove the primary load.

7. Tune the primary of the transformer for maximum reading at the LIM-1 jack.

8. Remove both loading resistors.

9. Replace the 8410-kc crystal (Y302).

290-KC IF TRANSFORMERS (T324 and T318)

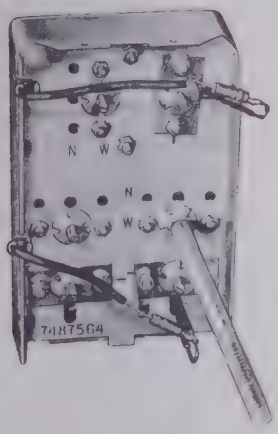
Equipment Required:

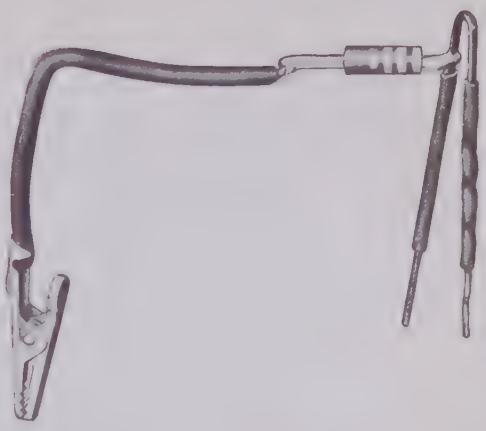
1. A non-metallic screwdriver.

2. A 0-100 microampere d-c meter (G-E Type EX-1-C).

3. A 290-kc signal source.

4. Two load resistor assemblies, made up as shown in Fig. 1, if resistor loading method is to be used. 22,000-ohm resistors are recommended for a wide-band transformer (T324) and 39,000-ohm resistors are recommended for a narrow-band transformer (T318).





LOADING RESISTOR ASSEMBLY

MATERIAL

1/4 watt resistor, common bobbypin, insulating sleeving for bobbypin, alligator clip and a 3-inch piece of test lead.

CONSTRUCTION

Flatten the tips of the bobbypin together so that they are flush, then spread the bobbypin legs out to form a "V". This is done so that when the bobbypin is inserted into the pin jack it will spread out and bind in the test jack for good electrical contact. Solder one lead of the resistor to one leg of the bobbypin near its loop, and solder the other resistor lead to the test lead terminated in an alligator clip. Clean and tin the bobbypin ends to prevent corrosion and to assure good electrical contact. Slide insulating sleeving over the bobbypin ends to prevent shorting. Sleeving should be tight enough to prevent slipping.

USING LOAD RESISTOR ASSEMBLY

Fasten the alligator clip to the chassis and insert the bobbypin into the pin jack. Two loading resistor assemblies can be used simultaneously while peaking coils in the six coil transformer assembly.

(RC-444A)

FIG. 1

Resistor Loading Procedure (Best):

1. Apply a 290-kc signal through a .01-mfd capacitor to XV304-2, when aligning the 1st LO IF.

2. Connect meter between LIM-1 jack (J302-green) and ground.

3. Refer to Fig. 1 for proper use of load resistors and Fig. 2 for location of coils and loading jacks.

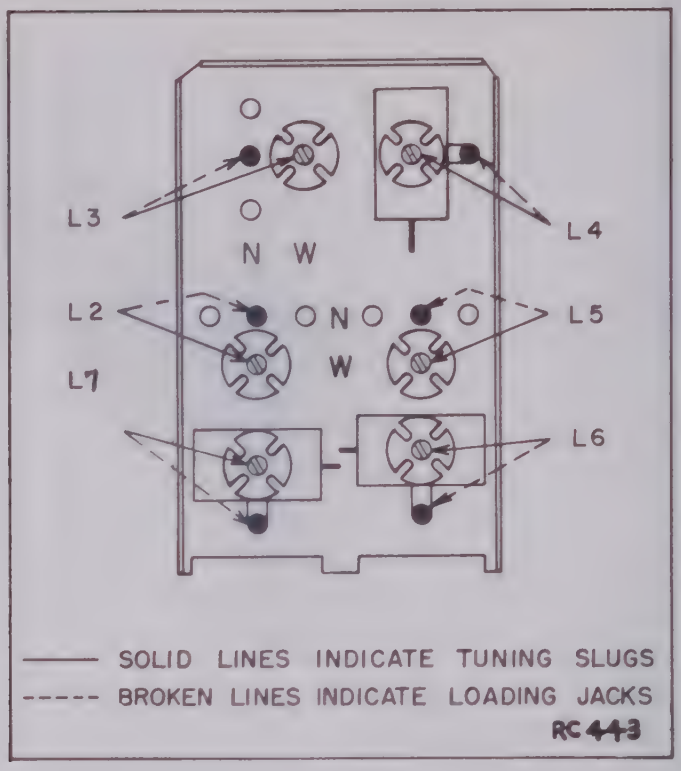


FIG. 2 Location of Tuning Slugs and Jacks, 290-kc IF Transformers - T324 and T318.

4. Load L-2 and peak L7.

5. Remove load from L-2. Load L7 and L-3 and peak L-2.

6. Remove loads from L7 and L-3. Load L-2 and L-4. Peak L-3.

7. Remove loads from L2 and L-4. Load L-3 and L-5. Peak L-4.

8. Remove loads from L-3 and L-5. Load L-4 and L-6. Peak L-5.

9. Remove loads from L-4 and L-6. Load L-5 and peak L-6.

10. Remove load resistor from L-5.

11. Repeat steps 4 to 10 to insure proper alignment.

Peak and Dip Procedure:

1. Locate tuning slugs and pin jacks as shown on Fig. 2.

2. Connect meter between L7 pin jack and ground.

3. Short coils with jumper wire and tune as in following table:

Short	Tune	Meter Reading
L-2	L7	Peak
L-3	L-2	Dip
L-4	L-3	Peak
L-5	L-4	Dip
L-6	L-5	Peak
None	L-6	Dip

FRONT END TUNING

The frequency of the receiver may be changed by replacing the 1st oscillator crystal and retuning the oscillator, multiplier and RF stages as described below.

If the frequency is changed by only one channel (60 kilocycles), the multiplier retuning can usually be omitted. The RF PLATE tuning transformer T332 and the antenna pre-selector, however, should always be retouched as they contain very selective circuits. If the receiver needs to be completely retuned, use the procedure outlined in the fore-going portion of this instruction.

Equipment required:

1. A non-metallic screwdriver.

2. A microammeter with a 0-50 and 0-500 microampere scales (General Electric Test Set Type EX-1-C) or a 20,000 ohm-per-volt voltmeter with a 0-3 volt scale.

3. A crystal of the proper frequency for the first oscillator (between 11.27 and 13.77 megacycles).

4. A signal generator with a 144-174 megacycle range, such as Measurements Corp. Model 80, General Radio 1021AV, or a Boonton 202-C. If a signal generator is not available when tuning the receiver in the field, connect the proper antenna to the receiver and transmit a weak signal from the transmitter with which the receiver is intended to operate.

Procedure:

To change frequency or align the RF and antenna stages, proceed as follows. Meter readings are between the jack indicated and ground.

1. Turn the receiver on and allow it to warm up for five minutes. Be sure that the battery or supply voltage is normal (6.6 or 13.2 volts d-c or 117 volts a-c.)

2. Insert the new crystal in the First Oscillator crystal socket. This is an octal socket and care must be exercised to place the crystal in the correct position.

3. Connect the 0-500 microammeter or the 0-3 volt meter to the OSC-1 jack, J305 (green-negative).

4. Tune the oscillator tank coil, Z301 for maximum oscillator grid meter indication. If there is any doubt about being on the correct peak, turn the adjustment fully counter-clockwise, then clockwise to the first peak. Note the reading and turn the iron core counterclockwise until the meter reads 80% of the maximum grid metering voltage or 1.3 volts whichever is lower. A minimum of about 1.1 volts should be obtained after tuning for 80% of the maximum with a standard supply voltage of 6.6 for 13.2 volts d-c or 117 volts a-c to the power supply. A 0-500 ua meter may be used for these measurements. However, not all microammeters will give the same reading depending on the internal resistance of the meter. For EX-1-C meter or 0-500 microampere range, the reading equivalent to 1.3 volts on the 0-3 v meter is 365 microamperes. Other multimeters may read as much as two to one lower.

5. Connect a microammeter or a 0-3 volt meter to the MULT jack, J306 (green-negative) and peak the top and bottom slugs of T310. This current should be 30 microamperes (.7 volts on a 0-3 volt meter) or more. Since the value of the shunt resistor is much higher in this circuit, the correct reading will be more than 30 microamperes on any multimeter or microammeter.

CAUTION

The recessed adjustment of ceramic trimmer capacitor C1 is in the B-plus circuit of multiplier transformer T311 or T326 and protected by a rubber grommet. Use caution around this capacitor.

6. Set trimmers of T311 (or T326) to approximately the correct position. At high end of receiver range (148 MC on 4ER25C, D1 or 11 or 174 MC on 4ER25C, D2 or 12) trimmer should be set at MIN (use dot of solder on ceramic part of rotor as a pointer). At low end of receiver range (144 MC on 4ER25C, D1 or 11 or 152 MC on 4ER25C, D2 or 12) trimmer should be set at maximum. Adjust proportionately for mid-frequencies.

7. Connect signal generator to pin 8 of XV302. Using maximum generator output, zero generator to discriminator. This zeroing should coincide with an increase in LIM-1 meter indication.

8. Reduce the signal generator output until the LIM-1 meter indicates below saturation, but above noise. Peak both trimmers of T311 (T326).

9. Move the signal generator to pin 1 of XV301. With the generator adjusted to zero discriminator and output below limiting, peak T332 (T333) trimmers marked RF on chassis. It is suggested that the grid circuit of the 1st Converter (C385) be tuned to resonance first, followed by the RF Amplifier plate circuit (C305).

10. Move the signal generator to the antenna jack (J1 on antenna transformer).

11. With the meter at LIM-1 (J302) and signal applied, peak the antenna transformer (T336 or T337) trimmer C8 and C9 (top and bottom of housing). Always peak trimmer C9 (bottom of housing) first and follow by peaking trimmer C8 (top of housing). Once peaked it is suggested that trimmers C9 and C8 of T336 or T337 be tuned for maximum quieting. Depending upon the receiver operating frequency, maximum LIM-1 current and maximum quieting may not occur together. Where this is the case, always tune for maximum quieting as noted on an output meter or in its absence by speaker response while keeping input signal level from signal generator low.

12. Recheck the RF and multiplier tuning. If possible monitor an unmodulated signal from a system transmitter for this check.

A) Recheck the adjustment of the OSC-1 trimmer (C352) for zero discriminator.

B) With a meter connected to J302, LIM-1 recheck the tuning of C8 and C9 of T336 (T337).

C) Recheck the setting of Z301-L1 (meter connected to J305, OSC) for 1.3 volt reading.

D) With meter connected to LIM-1, J302, recheck the peaking of T310, T311, (T326) and T332 (T333).

PHASE TUNING

Phase Tuning is very effective in improving receiver performance on noise having steep wave fronts (e.g. - ignition noise). The Phase Tuning procedure outlined below can only be used when the following conditions are met:

1. The Receiver must be properly aligned and have a sensitivity of 20 db of quieting for 0.4-uv input.

2. The discriminator reading on both noise and signal must be no greater than ± 0.2-volt on a d-c meter (20,000 ohms-per-volt)

Equipment Required:

1. A non-metallic screwdriver.

2. A 0-3 volt d-c meter or a 0-100 microampere d-c meter.

3. A 144 to 174 Mc signal source (signal generator or station transmitter).

4. A noise generator constructed as shown in Fig. 3.

Procedure:

1. Connect the antenna or signal generator, and the output of the noise generator to the Receiver antenna input through a "T" connector. If a noise generator is not available, phase tune the receiver in the vehicle, with the engine running and with the radio connected to the mobile antenna. Since generator noise cannot be phase tuned, be sure that the generator noise has been adequately suppressed at its source.

2. Connect meter between LIM-1 jack (J302-green) and ground.

3. Radiate a weak on-frequency signal enough to quiet the receiver about 20 to 25-db (40 to 70 microamperes at the LIM-1 jack).

4. Turn the noise generator switch to "ON".

5. Connect meter between DISC jack (J304-orange) and ground.

6. Tune L4 or L1 of T334 (one-quarter turn in either direction for a noise null while on zero discriminator).

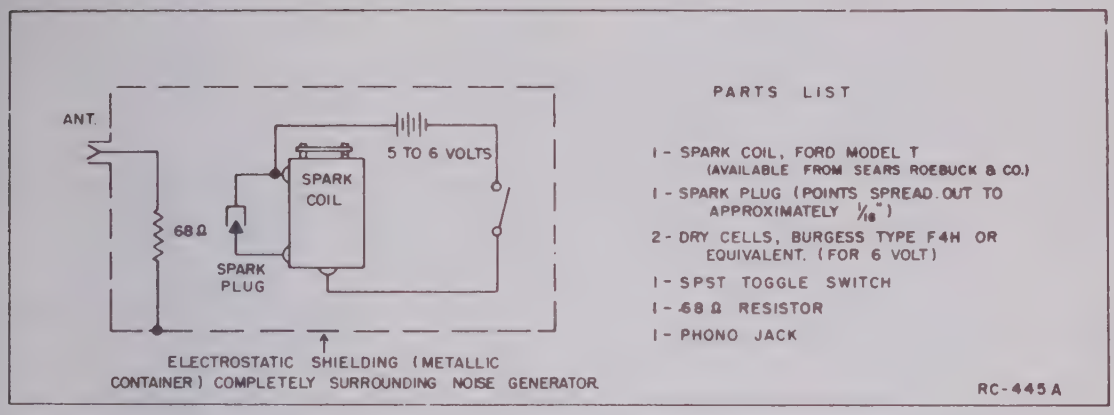

ANT.
5 TO 6 VOLTS
SPARK COIL
68Ω
SPARK PLUG
ELECTROSTATIC SHIELDING (METALLIC CONTAINER) COMPLETELY SURROUNDING NOISE GENERATOR
PARTS LIST
1 - SPARK COIL, FORD MODEL T (AVAILABLE FROM SEARS ROEBUCK & CO.)
1 - SPARK PLUG (POINTS SPREAD OUT TO APPROXIMATELY 1/16")
2 - DRY CELLS, BURGESS TYPE F4H OR EQUIVALENT. (FOR 6 VOLT)
1 - SPST TOGGLE SWITCH
1 - 68 Ω RESISTOR
1 - PHONO JACK
RC-445A

FIG. 3 - Noise Generator

7. If a noise null cannot be obtained, return the slugs to their original position. (maximum meter reading at LIM-1 jack), and proceed as follows:

Tune L4 and L6 of T324 or T318 for best noise null but do not turn slugs any more than one-quarter turn.

8. Recheck phase tuning in the high IF.

9. The loss of 1st LIMiter current should not exceed 5.0 microamperes as the result of phase tuning (an indication of mis-alignment of the low IF).

NARROW-BAND CONVERSION

This procedure describes how to convert a Type ER-25-D Receiver for narrow-band operation. Basically, the conversion involves changing the coupling in the 6-coil Lo-IF transformer, clipping out a coupling capacitor, and changing two resistors. Parts for making the conversion may be obtained by ordering Conversion Kit PL-4032043-G2. For users who desire the conversion without making it themselves, a narrow-band 6-coil Lo-IF transformer is available on an exchange basis. This transformer may be obtained by ordering PL-7487564-G5. Also specify if using a one or two frequency Transmitter.

PARTS REQUIRED

Number Required	Description	G-E Drawing and Part Number
1	Capacitor, ceramic: insulated, temp. compensating; 5.5 mmfd ± 0.10 mmfd, 500 V d-c W, -80 ±60 temp. coef.	B-7488184-P9
1	Capacitor, ceramic: insulated, temp. Compensating; 2.2 mmfd ± 0.10 mmfd, 500 V d-c W, -80 ± 120 temp. coef.	B-7488184-P8
1	Resistor, composition: 0.33 megohm ± 10%, 1/2 w.	C-3R77-P334K
2	Loading Resistors, composition: 39,000 ohms ±10%, 1/2 w.	C-3R77-P393K

PROCEDURE

1. Six-coil LO-IF transformer T324 should be either converted to narrow band, as described in this step, or replaced by a pre-tuned transformer (PL-7487564-G5) ordered from your G-E Service Shop or your nearest District Sales Office.

   (a) Disconnect the leads from transformer T324 and remove the transformer from the receiver chassis.

   (b) Remove the outside cover and the three small inner shields from T324.

   (c) Clip out and discard C3, the 7.25-mmfd coupling capacitor between L2 and L3; and C6, the 6.0-mmfd coupling capacitor between L4 and L5. See Fig. 4.

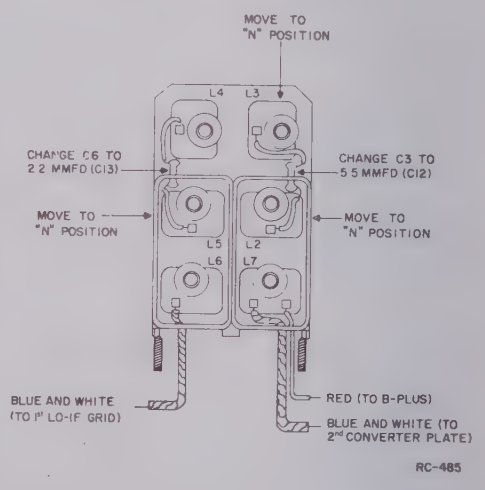


Fig. 4 - Narrow-Band Conversion of 6-Coil Transformer

   (d) Remove the mounting hardware (two #4 nuts and lockwashers) from coil L2 and remove the coil assembly. Then, while holding the slug inside the can, remove the tension nut from the top with a small screwdriver. Move the slug from the "W"

hole to the "N" hole and replace the tension nut back on the slug.

(e) Solder one end of 5.5-mmfd capacitor C12 to the same terminal of L2 from which C3 was removed in Step 3. Leave a lead length of one inch, covered by sleeving.

(f) Rotate the coil assembly 180° (to provide mechanical fit) and re-install it over the slug in the "N" holes.

(g) Remove the coil assembly and slug of L3 and re-install them in the "N" holes, following the same procedure used with L2.

(h) Solder the other end of the 5.5-mmfd capacitor to the same terminal of L3 from which C3 was clipped in Step 3. Use sleeving on lead.

(i) Remove the coil assembly and slug of L5 and re-install them in the "N" holes, following the same procedure used with L2.

(j) Solder one end of 2.2-mmfd capacitor C13 (using sleeving) to the same terminal of L5 from which C6 was removed in Step 3. Leave a lead length of one inch, covered by sleeving.

(k) Solder the other end of the 2.2-mmfd capacitor to the same terminal of L4 from which C6 was removed. Use sleeving on the lead.

(l) Replace the three inside shield covers on the transformer, remount it on the receiver chassis, and resolder the connections to T324:

Red Wire to TB12-1.
Blue & White Wire (plate) to TB12-2.
Blue & White Wire (grid) to XV305-1.

2. Make the following component changes:

(a) Solder a 330,000-ohm resistor from TB8-20 to TB8-7, in parallel with R386 (470K-ohm noise rectifier plate resistor).

(b) Clip out and discard R333 (33K-ohm resistor) from VOL. CONTROL HI to ground.

(c) Clip out and discard R406 (22K-ohm 2nd converter plate resistor).

(d) Clip out and discard C402 (3.0-mmfd capacitor across two-coil low-IF transformer T335).

3. Change the Receiver Model Number from 4ER25D1, 2, 11 or 12 to 4ER25C1, 2, 11 or 12, respectively. T324 should now be referred to as T318 (PL-7489565-G5).

4. Check the alignment of 6-coil transformer T318 and 2-coil transformer T335, as described earlier in this instruction. Replace the outside cover on T318.

5. If ignition noise interference is present after converting the receiver, it is recommended that the receiver be phase tuned. (See preceding section).

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

10ER8 Printed in U.S.A.

Block Diagram

144-152 MC RECEIVER
MODELS 4ER25C1,11 & D1,11
152-174 MC RECEIVER
MODELS 4ER25C2,12 & D2,12

(D-5497872, Rev. 4)

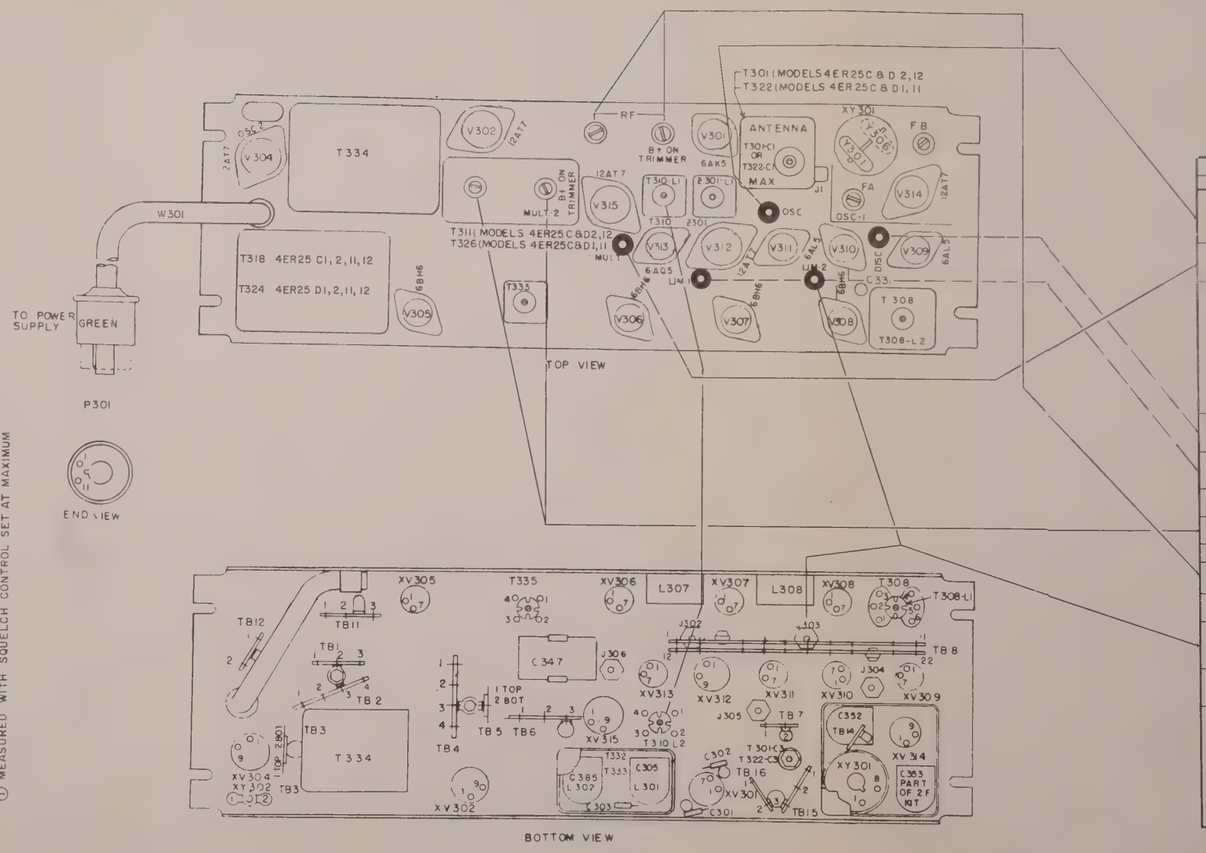
VOLTAGE FROM TUBE SOCKET PINS TO CHASSIS ±10% — RESISTANCE FROM TUBE SOCKET PINS TO CHASSIS ±20%

9	H	1	6	5	4	3	2	1	SYMBOL	TUBE TYPE	1	2	3	4	5	6	7	8	9
—	—	1	105	150	0	6.3	1	-.1 -.5 VT	XV301	6AR5	1.0 MEG	330	FIL	FIL	10K	68K	330	—	—
6.3	17	0	40	0	0/12.9	0	-.5	-.5	XV302	12AT7	500K	500K	0	FIL	FIL	800K	470K	6800	FIL
6.3	0	-17 -65 VT	18.0 24 GVT	0	0/12.9	15	12	130	XV304	12AT7	100K	47K	47K	FIL	FIL	750K	100K	0	FIL
—	—	0	100	100	0	6.3	.9	0	XV305	6BH6	50K	220	FIL	FIL	25K	25K	0	—	—
—	—	0	100	100	0/12.9	6.3	.9	0	XV306	6BH6	220K	220	FIL	FIL	25K	25K	0	—	—
—	—	GND	85	85	0	6.3	GND	-9 -30 VT	XV307	6BH6	220K	0	FIL	FIL	12K	12K	0	—	—
—	—	GND	70	70	0	6.3	GND	-24.0 -40.0VT	XV308	6BH6	200K	0	FIL	FIL	14K	14K	0	—	—
—	—	-24	GND	GND	6.3	-110 -235VT	-5		XV309	6AL5	75K	85K	FIL	FIL	0	0	80K	—	—
—	—	GND	165	155	0/12.9	6.3	0	-2.0	XV310	6BH6	470K	0	FIL	FIL	220K	120K	0	—	—
—	—	-70 -210VT	GND	2 15VT	0/12.9	6.3	-5 -90VT	-5 -90 VT	XV311	6AL5	0	0	FIL	FIL	2.2 MEG	0	12 MEG	—	—
6.3	35.0	2.0 30.0VT	195	0	0/12.9	GND	-.7 -18VT	2.0 30.0VT	XV312	12AX7	1.0 MEG	3.3MEG	0	FIL	FIL	240K	1.0MEG	18K	FIL
—	—	0	200	185	0/12.9	6.3	100	0	XV313	6AQ5	470K	270	FIL	FIL	400	0	470K	—	—
6.3	—	—	—	0	0/129	GND	-1.7 -15.0VT	155	XV314	12AT7	10K	47K	0	FIL	FIL	—	—	—	—
6.3	—	-4 -15.0VT	150	0	0	GND	-.75	180	XV315	12AT7	8K	240K	FIL	FIL	0	24K	220K	0	FIL

READINGS ARE TYPICAL VOLTAGES MEASURED ON A 20,000 OHM-PER-VOLT VOLTMETER (UNLESS OTHERWISE SPECIFIED) WITH POWER APPLIED TO THE UNIT. ALL MEASUREMENTS ARE MADE WITH A METER RANGE THAT GIVES BETWEEN APPROXIMATELY ONE-THIRD AND FULL-SCALE DEFLECTION. READINGS FOLLOWED BY "T" WERE OBTAINED WITH A HIGH IMPEDANCE VACUUM TUBE VOLTMETER

① MEASURED WITH SQUELCH CONTROL SET AT MAXIMUM

READINGS ARE TYPICAL RESISTANCES MEASURED WITH ALL POWER REMOVED FROM RECEIVER AND WITH ALL VOLTAGE SUPPLY LEADS GROUNDED. THE POWER CONTROL CABLE (W301) IS CONNECTED AND ALL TUBES ARE IN PLACE



SIMPLIFIED ALIGNMENT PROCEDURE

The following instructions cover the procedure for retuning the oscillator and RF stages of the receiver. If the receiver needs to be completely retuned use the procedure outlined in the RECEIVER BENCH ALIGNMENT PROCEDURE. If the receiver is to operate on two frequencies which are more than 180 kilocycles apart, the RF amplifier and multipliers should be tuned the receiver mid-frequency.

PRELIMINARY OPERATIONS

1. Be sure that a crystal of the proper frequency is in the high-frequency oscillator crystal socket.
2. Turn the power on and allow 2 or 3 minutes for warmup.

METERING JACK —	METERING JACK +	TUNING CONTROL	METER READING	PROCEDURE
OSC J305 green	GND (on Power Supply chassis) black	E301-L1	80% of Maximum (Do not exceed 375 microamp)	1. Peak E301-L1 (tuning slug on top of E301) and detune counterclockwise until meter reads 80% of maximum.
MULT J306 green	"	T310-L1 and T310-L2 (top and bottom slugs)	Maximum	2. Peak top and bottom slugs of T310. Bottom slug is accessible beneath chassis.
				3. If alignment of receiver is merely being checked, skip to Step 9. If receiver is known to be badly misaligned, set trimmers of T311 (or T326) to approximately correct position. At high end of receiver's range (148 MC on 4ER25A & B1,11 or 174 MC on 4ER29A & B2,12), capacitors should be set at minimum. (Use dot of solder on ceramic part of rotor as a pointer. Point of minimum capacitance is opposite mounting screws on capacitors.) At low end of range (144 MC on 4ER25A & B1,11 or 152 MC on 4ER25A & B2,12), capacitors should be set at MAX. Adjust proportionally for mid-frequencies.
DISC J304 orange	"	Adjust signal generator frequency	Zero	4. Connect signal generator at pin 8 of XV302. Using maximum generator output, zero generator to discriminator. This zeroing should coincide with an increase in LIM-1 current.
LIM-1	"		Increase	
				5. Reduce generator output until LIM-1 meter indicates below saturation, but above noise.
"	"	Both trimmers of T311 (or T326)	Maximum	6. Peak T311 (or T326).
				7. Move signal generator to pin 1 of XV301.
"	"	RF trimmers on T332 and T333.	Maximum	8. Peak T332 and T333.
				9. Move signal generator to antenna jack (J1 on antenna transformer).
"	"	Antenna transformer T336 (or T322)-C8 and C3 (top and bottom adjustments)	Maximum	10. Peak T301 (or T322).
"	"	T311, T332, and T301 (or T326, T333 and T322)	Maximum	11. Keeping LIN-1 current below 100 microamperes, peak T311, T332 and T301 (or T326, T333 and T322).
				12. Remove signal generator.
				13. While receiving strong, unmodulated signal at operating frequency, meter discriminator current. If discriminator meter reads more than ± 2 volts and transmitter is known to be on frequency, adjust OSC-1 trimmer (f_R) for zero discriminator reading.
				14. Repeat 1st step and repeak T311, T332 and T301.

_____SOLID LINES INDICATE TUNING CONTROLS

- - -BROKEN LINES INDICATE METERING JACKS

Service Outline

144-150.8 MC RECEIVER
MODELS 4ER25C1, 11 & D1, 11
150.80174 MC RECEIVER
MODELS 4ER25C2, 12 & D2, 12

(RC-467C)

HINTS FOR SERVICING

The following list of service hints, in addition to the Table of Typical Metering Voltages and the voltage-resistance chart (see reverse side of page) will assist the serviceman in locating the source of trouble if the Receiver should fail to operate properly.

PRELIMINARY CHECKS

The serviceman should first measure the LIM-1 and LIM-2 voltages and compare the readings with those recorded when the receiver was installed. A similar meter reading indicates that the RF and IF stages are operating properly.

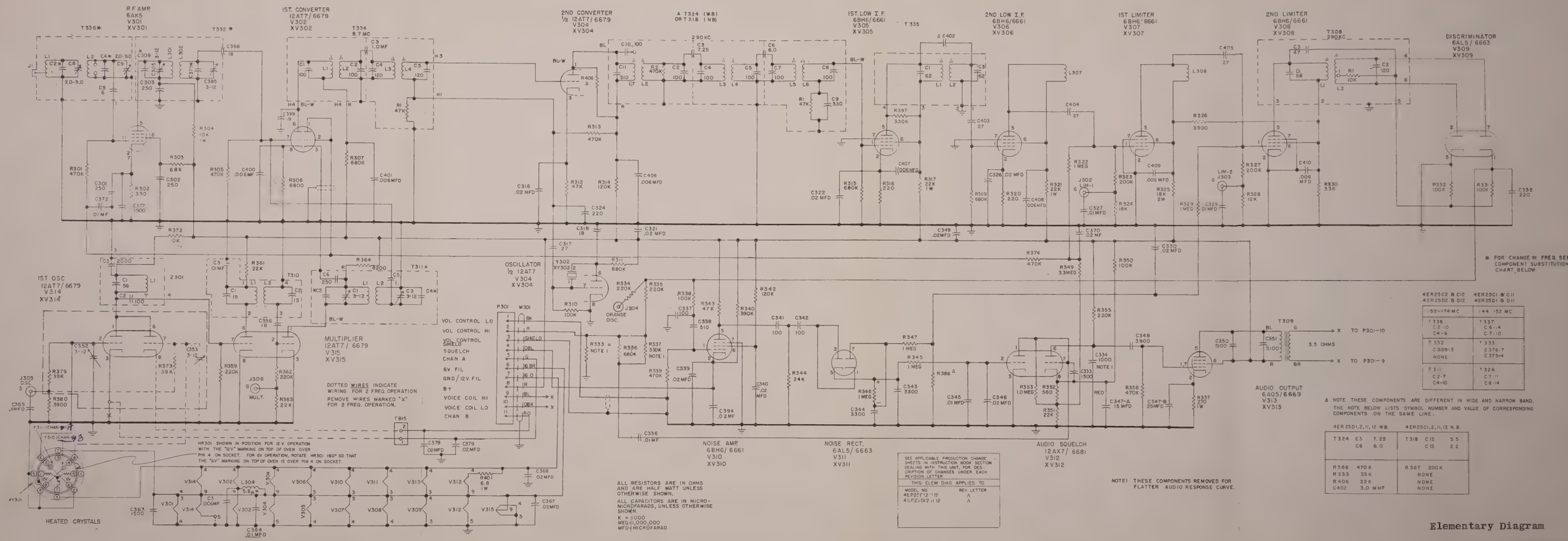
SYMPTOM	SERVICE CHECK
No filament or B-plus voltage.	Check connection of control cable to Power Supply.
	Refer to SERVICE OUTLINE for receiver Power Supply.
Low filament or B-plus voltage.	Check for defect in B-plus or filament circuit causing excess current drain. Check plug to Power Supply.
	Refer to SERVICE OUTLINE for receiver Power Supply.
LIM-1 and LIM-2 readings low.	Check B-plus voltages.
	Check tubes in RF and IF stages.
No crystal oscillator output indicated by low meter reading at OSC jack (J305).	Test V314 (12AT7) oscillator tube.
	Check B-plus voltage.
	Tune Z301 (see SIMPLIFIED ALIGNMENT PROCEDURE on reverse side of page).
Low MULT reading at J306.	Tune T310 (see SIMPLIFIED ALIGNMENT PROCEDURE on reverse side of page).
	Check tubes V315 and V314, the 1st Oscillator and Multiplier tubes.
	Check plate voltages on V315 and V314.
Low sensitivity, but normal readings at LIM-1 and LIM-2 jacks.	Check external antenna circuit.
	Tune T301 and T332 (see SIMPLIFIED ALIGNMENT PROCEDURE on reverse side of page).
No audio	Disable squelch by removing 6AL5 Noise Rectifier or 6BH6 Noise Amplifier. If audio breaks through, an unbalance exists in the squelch circuit.
	Short 6AQ5 cathode momentarily to ground. If loud click is not heard in speaker, look for defect in output transformer or voice coil leads. If loud click is heard, short 12AX7 audio section to ground. If a loud click is not heard, check coupling capacitor and B-plus voltage.
Squelch will not open	In stations, check muting relay on Power Supply.
	Test V310, V311 and V312. Check LIM-2 grid voltage.
	Check socket voltages (see Voltage-Resistance Chart on reverse side of page).
Intermittent reception.	Check for overdeviation of transmitter.
	Check to see if narrow-band receiver is being used in wide-band system.

TYPICAL METERING VOLTAGES

METER JACK		CIRCUIT	METER READING	
			VOLT METER*	MICROAMMETER**
AMP-2	J301	2nd Low IF Amplifier grid	Used for alignment purposes only.	
LIM-1	J302	1st Limiter grid	0.2 volt	10 microamp
LIM-2	J303	2nd Limiter grid	1.25 volts	200 microamp
DISC	J304	Discriminator	Should be set to zero by adjusting the 1st Oscillator trimmer on system frequency.	
OSC	J305	1st Oscillator grid	1.35 volts	300 microamp
MULT	J306	2nd Multiplier grid	0.9 volt	45 microamp

* Typical meter readings on 0 to 3-volt scale of a 20,000 ohm-per-volt voltmeter.

** Typical meter readings on a General Electric Test Set Type EX-1-C or an equivalent microammeter having an internal resistance of 2500 ohms.


R.F. AMP 6AK5 V301 XV301
1ST. CONVERTER 12AT7/6679 V302 XV302
2ND CONVERTER ½ 12AT7/6679 V304 XV304
1ST. LOW I.F. 6BH6/6661 V305 XV305
2ND LOW I.F. 6BH6/6661 V306 XV306
1ST LIMITER 6BH6/6661 V307 XV307
2ND LIMITER 6BH6/6661 V308 XV308
DISCRIMINATOR 6AL5/6663 V309 XV309
1ST OSC 12AT7/6679 V314 XV314
MULTIPLIER 12AT7/6679 V315 XV315
OSCILLATOR ½ 12AT7 V304 XV304
NOISE AMP 6BH6/6661 V310 XV310
NOISE RECT. 6AL5/6663 V311 XV311
AUDIO SQUELCH 12AX7/6681 V312 XV312
AUDIO OUTPUT 6AQ5/6669 V313 XV313
T336 * T332 * T334 8.7 MC T335 T324 (WB) OR T318 (NB) 290 KC T308 290KC
VOL CONTROL LO
VOL CONTROL HI
VOL CONTROL SHIELD
SQUELCH
CHAN A
6V FIL
GND/12V FIL
B+
VOICE COIL HI
VOICE COIL LO
CHAN B
DOTTED WIRES INDICATE WIRING FOR 2 FREQ. OPERATION
REMOVE WIRES MARKED "X" FOR 2 FREQ. OPERATION.
HR301 SHOWN IN POSITION FOR 12 V OPERATION WITH THE "12V" MARKING ON TOP OF OVEN OVER PIN 4 ON SOCKET. FOR 6V OPERATION, ROTATE HR301 180° SO THAT THE "6V" MARKING ON TOP OF OVEN IS OVER PIN 4 ON SOCKET.
HEATED CRYSTALS
* FOR CHANGE IN FREQ. SEE COMPONENT SUBSTITUTION CHART BELOW.
TO P301-10
TO P301-9
3.5 OHMS

	4ER25C2 & C12 4ER25D2 & D12	4ER25C1 & C11 4ER25D1 & D11
	150-174 MC	144 -152 MC
T336	C2-10 C4-6	T337 C6-4 C7-10
T332	C309-3 NONE	T333 C376-7 C375-4
T311	C2-7 C4-10	T326 C7-11 C8-14

△ NOTE THESE COMPONENTS ARE DIFFERENT IN WIDE AND NARROW BAND. THE NOTE BELOW LISTS SYMBOL NUMBER AND VALUE OF CORRESPONDING COMPONENTS ON THE SAME LINE.

	4ER25D1,2,11,12 WB	4ER25C1,2,11,12 N.B
T324	C3 7.25 C6 6.0	T318 C12 5.5 C13 2.2
R386	470 K	R387 200K
R333	33 K	NONE
R406	22 K	NONE
C402	3.0 MMF	NONE

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER

THIS ELEM DIAG APPLIES TO

MODEL NO	REV LETTER
4ER25C12 11 12	A
4ER25D12 11 12	A

ALL RESISTORS ARE IN OHMS AND ARE HALF WATT UNLESS OTHERWISE SHOWN.

ALL CAPACITORS ARE IN MICRO-MICROFARADS, UNLESS OTHERWISE SHOWN.

K = 1000
MEG = 1,000,000
MFD = MICROFARAD

NOTE! THESE COMPONENTS REMOVED FOR FLATTER AUDIO RESPONSE CURVE.

Elementary Diagram

144-150.8 MC RECEIVER
MODELS 4ER25C1,11 & D1,11
150.8-174 MC RECEIVER
MODELS 4ER25C2,12 & D2,12

(DD-5497070, Rev. 3)

PARTS LIST

144-150.8 MC RECEIVER MODELS 4ER25C1,2,11,12 REV. A AND 150.8-174 MC RECEIVER MODELS 4ER25D1,2,11,12 REV.A

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	CAPACITORS	
C301 and C302	Uncased, mica, 250 mmfd ± 10%, 500 v d-c w. Underwood Type J-1-HF modified.	A-7146331-G1
C303	Uncased, mica, 250 mmfd ± 10%, 500 v d-c w. Underwood Type J-1-HF modified.	A-7133474-G3
C304	Ceramic, variable; 3 to 12 mmfd, 500 v d-c w. Erie Type TS2A-NPO.	M-7484389-P2
C305	Ceramic, temp compensating, tubular; 3.0 mmfd ± 0.25 mmfd, 500 v d-c w, -220 temp coef. (Used in 4ER25C9 C12, 4ER25D2 and D12.)	P-7770468-P434
C306 and C379	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C307	Ceramic, temp compensating, tubular; 27 mmfd ± 2%, 500 v d-c w, -80 temp coef.	P-7770468-P249
C308	Ceramic, temp compensating, tubular; 18 mmfd ± 5%, 500 v d-c w, -80 temp coef.	P-7770488-P245
C309 and C322	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C310 and C399	Ceramic, temp compensating, tubular; 18 mmfd ± 10%, 500 v d-c w, -80 temp coef.	P-7770468-P212
C311	Ceramic, stabilized Hi-K disk; 220 mmfd ± 10%, 500 v d-c w. Radio Materials Corp. Type JL.	C-3881-P221K
C312	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C313	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C314	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C315	Ceramic, stabilized Hi-K disk; 220 mmfd ± 10%, 500 v d-c w. Radio Materials Corp. Type JL.	C-3881-P221K
C316	Ceramic, stabilized Hi-K disk; 1500 mmfd ± 10%, 500 v d-c w. Radio Materials Corp. Type JL.	C-3881-P152K
C317	Silver mica, dipped phenolic insulation; 1000 mmfd ± 10%, 500 v d-c w. Electro Motive Type DM-20.	A-7147203-P108
C318	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C319	Ceramic disk, insulated; 100 mmfd ± 10%, 500 v d-c w, -750 temp coef.	C-7774846-P621
C320	Silver mica, dipped phenolic insulation; 510 mmfd ± 10%, 300 v d-c w.	B-7489162-P144
C321	Ceramic, Hi-K disk; 0.02 mfd +100% -0%, 500 v d-c w.	C-7774750-P15
C323 and C324	Ceramic disk, insulated, temp compensating; 100 mmfd ± 10%, 500 v d-c w, -750 temp coef.	C-7774846-P621
C325 and C326	Ceramic, stabilized Hi-K disk; 3300 mmfd ± 10%, 500 v d-c w. Radio Material Corp Type JL.	C-3881-P332K
C327 and C328	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C329 and C330	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C331 and C332	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C333	Ceramic, stabilized Hi-K disk; 1500 mmfd ± 10%, 500 v d-c w. Radio Materials Corp. Type JL.	C-3881-P152K
C334	Silver mica, dipped phenolic insulation; 1000 mmfd ± 10%, 500 v d-c w. Electro Motive Type DM-20.	A-7147203-P108
C335 and C336	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C337	Ceramic disk, insulated, temp compensating; 100 mmfd ± 10%, 500 v d-c w, -750 temp coef.	C-7774846-P621
C338	Silver mica, dipped phenolic insulation; 510 mmfd ± 10%, 300 v d-c w.	B-7489162-P144
C339 and C340	Ceramic, Hi-K disk; 0.02 mfd +100% -0%, 500 v d-c w.	C-7774750-P15
C341 and C342	Ceramic disk, insulated, temp compensating; 100 mmfd ± 10%, 500 v d-c w, -750 temp coef.	C-7774846-P621
C343 and C344	Ceramic, stabilized Hi-K disk; 3300 mmfd ± 10%, 500 v d-c w. Radio Material Corp Type JL.	C-3881-P332K
C345	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C346	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C347	Electrolytic, insulated, tubular, sealed in metal tube; 15 mfd +100% -10%, 150 v d-c w; 25 mfd +250% -10%, 25 v d-c w.	B-7488699-P2
C348	Silver mica, dipped phenolic insulation; 3900 mmfd ± 10%, 500 v d-c w. Electro Motive Mfg. Type DM-20.	A-7147203-P122
C349	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C350 and C351	Ceramic, stabilized Hi-K disk; 5100 mmfd ± 10%, 500 v d-c w. Radio Material Corp Type JL.	C-3881-P512K
C352 and C353	Ceramic, variable, 3 to 12 mmfd, 500 v d-c w. Erie Type T32A-NPO.	M-7484389-P2
C356	Ceramic, temp compensating, tubular; 18 mmfd ± 10%, 500 v d-c w, -80 temp coef.	P-7770468-P212
C363	Ceramic, Hi-K disk; 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C364	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C365 and C366	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C367 and C368	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C369	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C370	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C371#	Deleted by Rev. A.	
C372	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C373	Ceramic, temp compensating, tubular, 4.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef. (Used in 4ER25C11 and 4ER25D1 and D11 only).	P-7770468-P233
C376	Ceramic, temp compensating, tubular, 7.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef. (Used in 4ER25C1 and C11, 4ER25D1 and D11).	P-7770468-P238
C377	Ceramic, Hi-K disk; 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C378 and C379	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C385	Ceramic, variable; 3 to 12 mmfd, 500 v d-c w. Erie Type T32A-NPO.	M-7484389-P2
C386#	Ceramic disk, insulated; 6000 mmfd ± 20%, 500 v d-c w. RMC Corp. Type JF Discap. Added by Rev. A.	B-3494481-P19
C394	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	P-7488160-P2
C398 and C399	Ceramic, temp compensating, tubular; 18 mmfd ± 10%, 500 v d-c w, -80 temp coef.	P-7770468-P212
C400#	Ceramic disk, insulated; 6000 mmfd ± 20%, 500 v d-c w. RMC Corp. Type JF Discap. Changed by Rev. A.	B-3494481-P19
C401	Ceramic disk, insulated; 6000 mmfd ± 20%, 500 v d-c w. RMC Corp Type JF Discap.	C-5494481-P19
C402	Ceramic, temp compensating, tubular, 3.0 mmfd ± 0.25 mmfd, 500 v d-c w. (Used in 4ER25D1, D2, D11 and D12 only).	P-7770468-P34
C403 thru C405	Ceramic disk, insulated; temp compensating; 27 mmfd ± 5%, 500 v d-c w, -150 temp coef.	C-7774846-P249
C406 thru C410	Ceramic disk, insulated; 6000 mmfd ± 20%, 500 v d-c w. RMC Corp Type JF Discap.	C-5494481-P19
	CRYSTAL OVEN	
HR301	13.0 V in 12 V condition and 6.0 V in 6 V condition; operating internal average temp 85°C ± 3°C.	B-5490303-P1
	JACKS AND RECEPTACLES	
J302 and J303	Test point, stake in, molded nylon body. Alden Products Co. Part #110BCL1-green.	A-4029486-P4
J304	Test point jack, stake in, molded nylon. Alden Products Co. Type #110BCl-orange.	A-7150763-P8
J305 and J306	Test point jack, stake in, molded nylon. Alden Products Co. Type #110BCl-green.	A-7150763-P4
	INDUCTORS	
L301 and L302	RF transformer coils.	A-7141042-P1
L304	RF choke coil; inductance 5.6 uh ± 10%. Jeffers Cat. #10203-20.	B-7488079-P40
L307 and L308	RF choke coil; maximum dc current 5 ma, inductance must not be less than 13.5 MH at 79 KC, coil must resonant when tuned to 990 KC with 18 mmfd ± 3 mmfd. Minimum Q35 at 200 KC.	A-7147279-P1
	PLUG	
P301	Part of W301.	

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	RESISTORS	
R301	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3877-P474K
R302	Composition, 330 ohms ± 10%, 1/2 w.	C-3877-P331K
R303	Composition, 68,000 ohms ± 10%, 1/2 w.	C-3877-P683K
R304	Composition, 10,000 ohms ± 10%, 1 w.	C-3878-P103K
R305	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3877-P474K
R306	Composition, 3300 ohms ± 10%, 1/2 w.	C-3877-P082K
R307	Composition, 0.68 megohm ± 10%, 1/2 w.	C-3877-P684K
R310	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3877-P104K
R311	Composition, 0.68 megohm ± 10%, 1/2 w.	C-3877-P684K
R312	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3877-P473K
R313	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3877-P474K
R314	Composition, 0.12 megohm ± 10%, 1/2 w.	C-3877-P124K
R315	Composition, 0.68 megohm ± 10%, 1/2 w.	C-3877-P684K
R316	Composition, 220 ohms ± 10%, 1/2 w.	C-3877-P221K
R317	Composition, 22,000 ohms ± 10%, 1 w.	C-3878-P223K
R320	Composition, 220 ohms ± 10%, 1/2 w.	C-3877-P221K
R321	Composition, 22,000 ohms ± 10%, 1 w.	C-3878-P223K
R322	Composition, 1.0 megohm ± 10%, 1/2 w.	C-3877-P105K
R323	Composition, 0.20 megohm ± 5%, 1/2 w.	C-3877-P204J
R324	Composition, 10,000 ohms ± 10%, 1/2 w.	B-7487281-P2
R325	Composition, 18,000 ohms ± 10%, 2 w.	C-3879-P183K
R326	Composition, 3900 ohms ± 10%, 1/2 w.	C-3877-P392K
R327	Composition, 0.20 megohm ± 5%, 1/2 w.	C-3877-P204J
R328	Composition, 12,000 ohms ± 10%, 1/2 w.	C-3877-P123K
R329	Composition, 1.0 megohm ± 10%, 1/2 w.	C-3877-P105K
R330	Composition, 33,000 ohms ± 10%, 1/2 w.	C-3877-P333K
R331 and R332	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3877-P104K
R333	Composition, 33,000 ohms ± 10%, 1/2 w, (Used in 4ER25D1, D2, D11, and D12 only.)	C-3877-P333K
R334 and R335	Composition, 0.22 megohm ± 10%, 1/2 w.	C-3877-P224K
R336	Composition, 0.68 megohm ± 10%, 1/2 w.	C-3877-P684K
R337	Composition, 0.33 megohm ± 10%, 1/2 w.	C-3877-P334K
R338	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3877-P104K
R339	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3877-P474K
R340	Composition, 0.39 megohm ± 10%, 1/2 w.	C-3877-P394K
R342	Composition, 0.12 megohm ± 10%, 1/2 w.	C-3877-P124K
R343	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3877-P473K
R344	Composition, 24,000 ohms ± 5%, 1/2 w.	C-3877-P243J
R345 thru R347	Composition, 1.0 megohm ± 10%, 1/2 w.	C-3877-P105K
R349	Composition, 3.3 megohm ± 10%, 1/2 w.	C-3877-P335K
R350	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3877-P104K
R351	Composition, 22,000 ohms ± 10%, 1/2 w.	C-3877-P223K
R352	Composition, 560 ohms ± 10%, 1/2 w.	C-3877-P561K
R353	Composition, 1.0 megohm ± 10%, 1/2 w.	C-3877-P105K
R355	Composition, 0.22 megohm ± 10%, 1/2 w.	C-3877-P224K
R356	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3877-P474K
R357	Composition, 270 ohms ± 10%, 1 w.	C-3878-P271K
R359	Composition, 0.22 megohm ± 10%, 1/2 w.	C-3877-P224K
R361	Composition, 22,000 ohms ± 10%, 1/2 w.	C-3877-P223K
R362	Composition, 0.22 megohm ± 10%, 1/2 w.	C-3177-P224K
R363	Composition, 22,000 ohms ± 10%, 1/2 w.	C-3877-P223K
R364	Composition, 8200 ohms ± 10%, 1/2 w.	C-3877-P822K
R369	Composition, 0.68 megohm ± 10%, 1/2 w.	C-3877-P684K
R372	Composition, 10,000 ohms ± 10%, 1/2 w.	C-3877-P103K
R373	Composition, 39,000 ohms ± 10%, 1/2 w. (Used in 4ER25C11 and C12, 4ER25D11 and D12 only.)	C-3977-P393K
R374	Composition, 0.47 megohm ± 10%, 1/2 w. (Used in 4ER25C2, C12, and 4ER25D2 and D12.)	C-3877-P474K

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	RESISTORS (CONT'D)	
R379	Composition, 39,000 ohms ± 10%, 1/2 w.	C-3877-P393K
R380	Composition, 3900 ohms ± 10%, 1/2 w.	C-3877-P392K
R386	Composition, 0.47 megohm ± 10%, 1/2 w. (Used in 4ER25D1, D2, D11, and D12 only.)	C-3877-P474K
R387	Composition, 0.20 megohm ± 5%, 1/2 w. (Used in 4ER25C1, C2, C11, and C12 only.)	C-3877-P204J
R397	Composition, 0.33 megohm ± 10%, 1/2 w.	C-3877-P334K
R401	Composition, 6.8 ohms ± 5%, 1 w.	B-5490205-P1
R406	Composition, 22,000 ohms ± 10%, 1/2 w. (Used in 4ER25D1, D2, D11 and D12 only.)	C-3877-P223K
	TRANSFORMERS	
T301#	Deleted by Rev. A.	
T308	Discriminator. Includes the following electrical components with T308 prefix.	PL-7774567-G1
T308-C1	Ceramic, temp compensating, 68 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	P-7772250-P229
T308-C2	Ceramic, temp compensating, tubular, 120 mmfd ± 5%, 500 v d-c w, -80 temp coef.	P-7770468-P265
T308-C3	Ceramic, temp compensating, tubular; 47 mmfd ± 5%, 500 v d-c w, -80 temp coef.	P-7770468-P255
T308-R1	Composition, 10,000 ohms ± 10%, 1/2 w.	C-3877-P103K
T309	Audio output; Pri impedance 5200 ohms ± 10%, with 3.5 ohm resistive load on sec. A-7128778 Type "F" construction and compound filled case.	B-7487281-P2
T310	1st Multiplier. Includes the following electrical components with T310 prefix.	PL-7748460-G1
T310-C1 and T310-C2	Ceramic disk, insulated, temp compensating; 15 mmfd ± 5%, 500 v d-c w, -80 temp coef.	C-7774846-P244
T310-C3	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
T311	2nd Multiplier. Includes the following electrical components with T311 prefix. (Used in 4ER25C2 and C12, 4ER25D2 and D12 only.)	PL-7147727-G1
T311-C1	Uncased, 47 mmfd ± 10%, 500 v d-c w. Underwood Type J-1-HF.	M-7483389-P2
T311-C2	Ceramic, temp compensating, tubular; 7.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P238
T311-C3	Uncased, 47 mmfd ± 10%, 500 v d-c w. Underwood Type J-1-HF.	M-7484389-P2
T311-C4	Ceramic, temp compensating tubular; 10 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P241
T311-C5	Ceramic, temp compensating, tubular, 1.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P231
T311-C6	Uncased mica, 250 mmfd ± 10%, 500 v d-c w. Underwood Type J-1-HF modified.	PL-7133474-G3
T311-L1 and T311-L2	Coil; 1.50 turns, right hand close wound, #16 Awg. of copper magnet wire, single coated vinyl acetal.	A-7145524-P1
T318	1st Low I.F. Includes the following electrical components with T318 prefix. (Used in 4ER25C1, C2, C11 and C12 only).	PL-7487564-G5
T318-C1	Silver mica, CM15 case, 510 mmfd ± 5%, 300 v d-c w. Electro Motive Mfg. Type CM-15.	P-3R122-P64
T318-C2	Ceramic disk, temp compensating; 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	C-7774970-P221
T318-C4 and T318-C5	Ceramic disk, temp compensating; 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	C-7774970-P221
T318-C7 and T318-C8	Ceramic disk, temp compensating; 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	C-7774970-P221
T318-C9	Silver mica, CM15 case; 330 mmfd ± 10%, 500 v d-c w. Electro Motive Mfg. Type CM-15.	P-3R122-P24
T318-C10	Ceramic disk, temp compensating; 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	C-7774970-P221
T318-C12	Ceramic, insulated, temp compensating, 5.50 mmfd ± 0.10 mmfd, 300 v d-c w, -80 ± 60 temp coef.	B-7488184-P9
T318-C13	Ceramic, insulated, temp compensating; 2.20 mmfd ± 0.10 mmfd, 300 v d-c w, -80 ± 150 temp coef.	B-7488184-P6
T318-L1	Coil.	PL-7140920-G4
T318-L2	Coil.	PL-7147921-G2

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	TRANSFORMERS (CONT'D)	
T318-L3 thru T318-L5	Coil.	PL-7140921-G1
T318-L6	Coil.	PL-7140922-G1
T318-R1	Composition, 47,000 ohms ± 10% 1/2 w.	C-3877-P473K
T318-R2	Composition, 0.47 ohm ± 5%, 1/2 w.	C-3877-P474J
T318-L2	Coil, intermediate.	PL-7140921-G2
T318-L3	Coil, intermediate.	PL-7140921-G1
T318-L4 and T318-L5	Coil, intermediate.	PL-7140921-G1
T318-L6	Coil, grid.	PL-7140922-G1
T318-L11	Coil, plate.	PL-7140920-G4
T322#	Deleted by Rev. A.	
T324	1st Low I.F. Includes the following electrical components with T324 prefix. (Used in 4ER25D1, D2, D11 and D12 only.)	PL-7487564-G4
T324-L1	Coil.	PL-7140920-G4
T324-L2	Coil.	PL-7140921-G2
T324-L3 thru T324-L5	Coil.	PL-7140921-G1
T324-L6	Coil.	PL-7140922-G1
T324-R1	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3877-P473K
T324-R2	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3877-P474K
T324-L2	Coil, intermediate.	PL-7140921-G2
T324-L3 thru T324-L5	Coil, intermediate.	PL-7140921-G1
T324-L6	Coil, grid.	PL-7140922-G1
T324-L11	Coil, plate.	PL-7140920-G4
T326	Second multiplier. Includes the following electrical components with T326 prefix. (Used in 4ER25C1 and C11, 4ER25D1 and D11.)	PL-7140727-G2
T326-C1 and T326-C3	Ceramic, variable; 3 to 12 mmfd, 500 v d-c w. Erie Type T32A-NPO.	M-7484389-P2
T326-C5	Ceramic, temp compensating, tubular, 1.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P231
T326-C6	Uncased mica, 250 mmfd ± 10%, 500 v d-c w. Underwood Type J-1-HF modified.	PL-7133474-G3
T326-C7	Ceramic, temp compensating, 11.0 mmfd ± 5%, 500 v d-c w. Erie Type 331.	M-7473483-P13
T326-C8	Ceramic, temp compensating, 14.0 mmfd ± 5%, 500 v d-c w. Erie Type 331.	M-7473483-P14
T326-L1 and T326-L2	Coil: 1.50 turns, right hand close wound, #16 Awg. of copper magnet wire, single coated vinyl acetal.	A-7145524-P1
T332	Consists of the following components; C303, C309, C385, L301 and L302. (Used in 4ER25C8 and C12; 4ER25D2 and D12 only.)	
T333	Consists of the following components, C305, C373, C385, L301 and L302; (Used in 4ER25C1 and C11, 4ER25D1 and D11 only.)	
T334	Transformer, 8.7 Kc. Includes the following electrical components with T334 prefix.	PL-7488039-G2
T334-C3	Ceramic, insulated, temp compensating, 1.0 mmfd ± 0.10 mmfd, 500 v d-c w, -80 temp coef.	B-7488184-P7
T334-C9	Ceramic, disk; insulated, temp compensating, 100 mmfd ± 5%, 500 v d-c w, -80 temp coef.	P-7774846-P265
T334-C10 thru T334-C12	Ceramic disk, insulated, temp compensating, 120 mmfd ± 5%, 500 v d-c w, -80 temp coef.	P-7774846-P265
T334-L7	Coil, plate.	PL-7145446-G5
T334-L8 and T334-L9	Coil, intermediate.	PL-7145445-G4
T334-L10	Coil, plate (PL-7145446-P18.)	PL-7145447-G3
T334-R3	Composition, 47,000 ohms ± 10%, 1/2 w.	C-3877-P473K
T334-L7	Coil, plate.	PLA-7145446-G5
T334-L8	Coil, intermediate.	PLA-7145445-G4
T334-L9		
T336-C2#	Ceramic, temp compensating, tubular; 1L mmfo ± 5.25 mmfd, 500 v d-c w, -80 temp coef.	1-7770468-P241
T336-C4#	Ceramic, temp compensating, tubular; 6.6 mmfo ± 0.25 mfd, 500 v d-c w, -80 temp coef.	P-7770468-P257
T336-C5#	Ceramic, insulated, temp compensating; 9.00mmfc ± 0.25 mmfd, 500 v d-c w, -80 ± 80 temp coef.	B-7488184-P5
T336-C8# and T336-C9#	Variable air; 2.13 to 8.73 mmfd, 1250 v peak.	M-7481113-P12
T336-J1#	Phono type; mica-filled phenolic. Similar to Cinch Cat. #14UG196, except silver plate.	K-7140491-P7
T336-L1# and T336-L2#	Coil; 6.5 turns per inch, right hand wound, 0.47 inches, ID ± 0.01 inches.	A-7145464-P1
T337#	Antenna. Includes the following electrical components with T337 prefix. (Used in 4ER25C1 and C11, 4ER25D1 and D11 only.) Added by Rev. A.	PL-7144654-G4
T337-C5#	Ceramic, insulated, temp compensating; 6.6C mmfo ± 0.25 mmfd, 500 v d-c w, -80 ± 80 temp coef.	B-7481184-P5
T337-C6#	Ceramic, temp compensating; 14.6 mmfc ± 5%, 500 v d-c w. Erie Type 331.	M-7473483-P14
T337-C7#	Ceramic, temp compensating, tubular; 1L mmfo ± 1.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P241
T337-C8# and T337-C9#	Variable air; 2.13 to 8.73 mmfd, 1250 v peak.	M-7481113-P13
T337-J1#	Phono type; mica-filled phenolic. Similar to Cinch Cat. #14UG196, except silver plate.	K-7140491-P7
T337-L1# and T337-L2#	Coil: 6.5 turns per inch, right hand wound, 0.47 inches, ID ± 0.01 inches.	A-7145464-P1
	TUBES	
V301	Type 6AK5.	
V302	Type 6J76/12AT7.	
V303	Type 6J70/12AT7.	
V304 thru V306	Type 6J83/6BH6.	
V307	Type 6J21/6BN6.	
V308	Type 6J83/6AL5.	
V309	Type 6J21/6BN6.	
V310	Type 6J61/6AL5.	
V311	Type 6J69/6AU6.	
V312	Type 6J81/12AT7.	
V313	Type 6J69/6AU6.	
V314 and V315	Type 6J61/12AT7.	
	CABLE	
W301	Cable assembly includes; connector with 11-male contacts, black phenolic plug (GE Dwg and Part No. A-4031L21-P1), with metal cap metal stamped with the letter "E", (GE Dwg and Part No. A-4031J19-P1); or an 11-pin male plug; green, molded type with the letter "R" molded in the connector, Component Mfg. Service Cat. #1561-M11.	B-7489384-P1

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	SOCKETS	
XV-1	Tube socket; mica filled phenolic, 7 pin miniature, top mount, flat top. RETMA Type TS27TP01.	P-7768887-P9
XV302	Tube Socket; mica filled phenolic, 9 pin miniature. RETMA Type TSE-9T-201.	M-7483532-P3
XV303	Tube socket; mica filled phenolic, 9 pin miniature, saddle type, top mount.	A-7144657-P1
XV304 and XV306	Tube socket; mica filled phenolic, 7 pin miniature, top mount, flat top.	P-7768887-P2
XV305	Tube socket; mica filled phenolic, 7 pin miniature, top mount, flat top. RETMA type TS27TP01.	P-7768887-P9
XV307	Tube Socket; mica filled phenolic, 7 pin miniature, top mount, flat top. RETMA Type TS27TP01.	1-7770468-P241
XV308	Tube socket; mica filled phenolic, 7 pin miniature, top mount, flat top.	P-7770468-P257
XV309	Tube Socket, mica filled phenolic, 7 pin miniature, top mount, flat top.	P-7768887-P2
XV310	Tube Socket, mica filled phenolic, 7 pin miniature, top mount, flat top. RETMA Type TS27TP01.	P-7768887-P9
XV311 and XV312	Tube socket; mica filled phenolic, 9 pin miniature, saddle type, top mount.	A-7144657-P1
XV313	Tube socket, mica filled phenolic, 7 pin miniature, top mount, flat top.	P-7768887-P2
XV314 and XV315	Tube socket, mica filled phenolic, 9 pin miniature, RETMA Type TSE-9T-201.	M-7480532-P3
	CRYSTALS	
XY301	Crystal socket and ring; octal, mica filled yellow and black phenolic with 2 diametrically opposed keyways. Similar to Cinch Cat. #51E18U71.	A-7147225-P1
XY302	Crystal socket; 2 pin steatite. HH Eby type CR-7, Cat. #9506	K-7128948-P1
	When reordering crystals give G-E Dwg and Part No. and specify exact frequency needed. Initial Frequency = (Operating frequency - 8.7 Kc) ± 12.	
XY303	Crystal, quartz, 841C.00C KC.	A-7145355-P1
XY304	One 88°C crystal for use in Crystal Oven HR301.	B-7488063-P5
XY305	One 88°C crystal for use in Crystal Oven HR301. (Used in 4ER25C11, C12; 4ER26D11 and D12 only).	B-7488901-P5
	TUNER	
A301	Tuner assembly. Includes the following electrical components with T301 prefix.	PL-7488670-G2
L301-C1	Ceramic, disk, insulated, temp compensating; 50 mmfd ± 5%, 500 v d-c w, -150 temp coef.	C-7774846-P237
L301-C2	Ceramic, disk, insulated, temp compensating 100 mmfd ± 10%, 500 v d-c w, -750 temp coef.	C-7774846-P621
L301-C3	Ceramic, stabilized Hi-K disk; 3000 mmfd ± 10%, 500 v d-c w. Radio Material Corp Type J.	C-3881-P262K
L301-L2	Coil assembly.	A-7145238-G2

INSTRUCTIONS
FOR
TONE-COMPENSATING NETWORK PL-7150715-G6

Tone-Compensating Network PL-7150715-G6 is added to a Station VHF Receiver when its discriminator output is used in conjunction with a Cathode Follower Kit to supply the voice modulation for a relay VHF Transmitter. For reference, refer to the Elementary Diagram A-4029866.

INSTALLATION

To install the Tone-Compensating Network in VHF Receivers 4ER24A, B and C or 4ER25B, C and D, follow the instructions on sheet 1 of Installation Diagram A-4029865. For installation in VHF Receiver 4ER26B follow the instructions on sheet 2 of Installation Diagram A-4029865.

PARTS LIST

Symbol	Description	G-E Drawing
C7	Capacitor: ceramic, stabilized Hi-K disk; 1500 mmfd ± 20%, 500 v d-c w. Radio Material Corp. Type JL.	C-3R81-P152M
R9	Resistor: composition 0.10 megohm ± 5%, 1/2 w.	C-3R77-P104J
W1	Cable assembly: includes cable two conductor #22 awg stranded thermo-plastic and nylon insulated, shielded and nylon jacketed, 12.00 ± 0.40 inches long; and two terminals, wire spade, copper-tin plated, Aircraft Marine Prod. Cat. #41753 or equiv.	PL-4029214-G1

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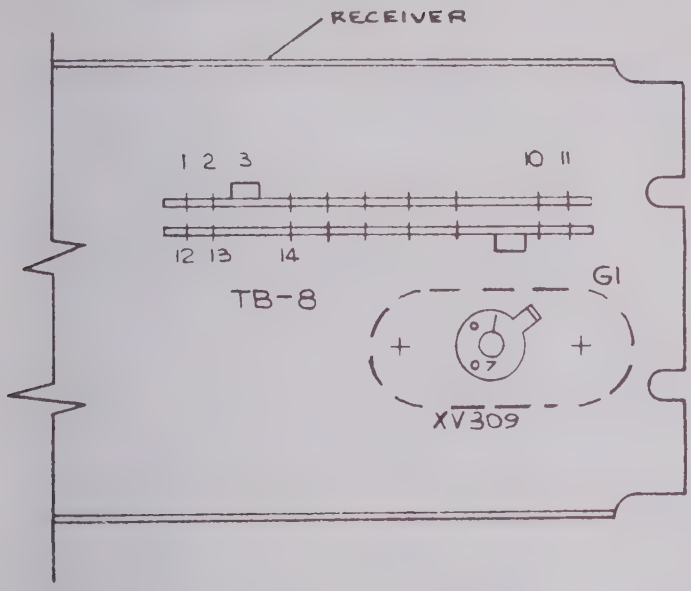
. ER24A,B, & C & ER25B,C & D



. Add R9 (100K) from XV309-C to TB8-11.
. ADD C7 (1500) from TB8-11 to XV309-G1.
. Attach unterminated end of W1 as follows. Do not route cable through chassis.

Red to TB8-11
Black to XV309-G1

. Stamp option letter L on receiver chassis near model number.
. When receiver is in station power supply:

A) Attach the terminals of W1 to the KC-4-B, KC-10-A control panel terminal board.

Red wire to TB702-4.
Black wire and shield to TB702-5.

B) Connect cathode follower kit.

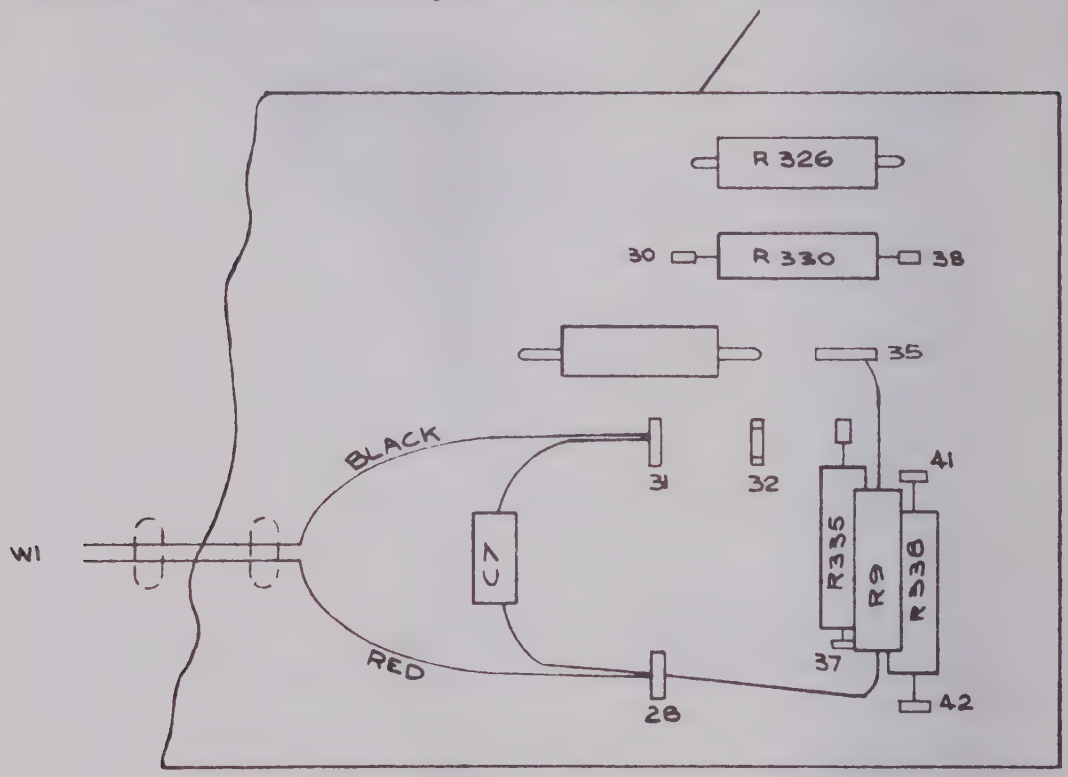
Installation Diagram

STATION RECEIVER TONE COMPENSATING KIT PL-7150715-G6

(A-4029865, Sheet 1 , Rev. 0)

5ER10

ER26B Receiver with Component Board B-7491287.



1. Connect R9 (100K) between pin #35 and pin #28.
2. Connect C7 (1500 mmf) between pin #28 and pin #31.
3. Attach unterminated end of W1 as follows. Do not route through chassis.

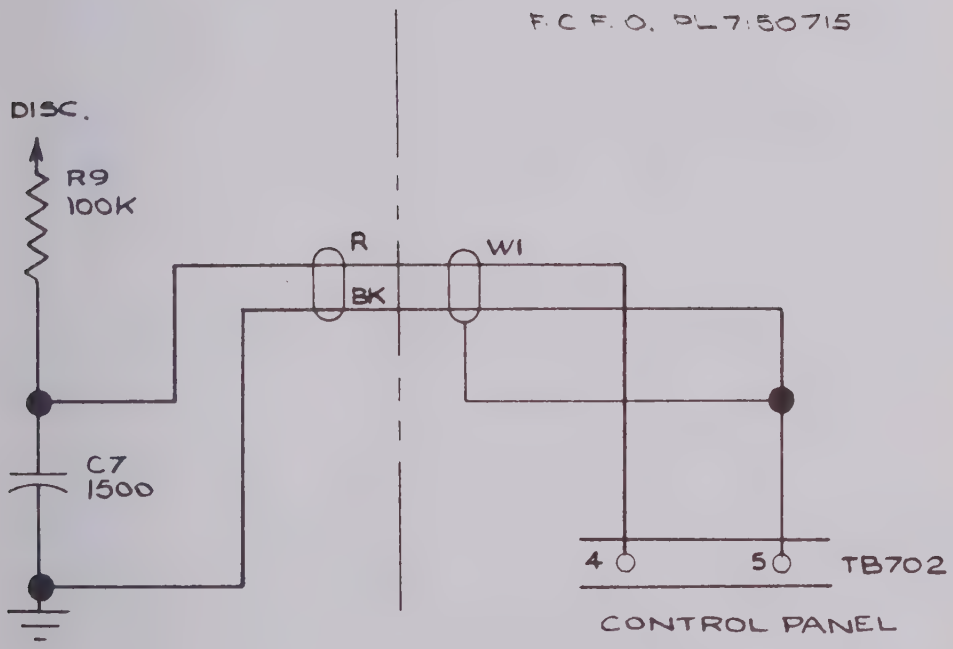
   Red to pin #28
   Black to pin #31.

4. See steps A-4 and A-5.

Installation Diagram

STATION RECEIVER TONE COMPENSATI
KIT PL-7150715-G6

(A-4029865, Sheet 2, Rev. 0)



4KC10A3
4KC10A2 REV. B OR LATER
4KC4B1
4KC4B2

RECEIVER

ER-24-A
ER-24-B
ER-24-C
ER-25-B
ER-25-C
ER-25-D
ER-26-B

Elementary Diagram

STATION RECEIVER TONE COMPENSATING KIT PL-7150715-G6

(A-4029866, Rev. 0)

INSTALLATION INSTRUCTIONS FOR RECEIVER REAR SHIELD KIT PL-7144420-G1 (for Receiver ER-24-A,B and ER-25A,B)

When Receiver ER-24-A, ER-24-B, ER-25-A, or ER-25-B is used in station combinations where it is to operate simultaneously with a transmitter in the same cabinet, such as in radio relay applications, a rear shield should be added on the back of the receiver. This shield prevents direct radiation from the transmitter to the grid and plate leads of the receiver tubes. Under certain conditions, however, some of the leads entering the shield may introduce appreciable signal strength from the transmitter directly to the bottom of the receiver chassis. Plug buttons have been provided in the shield so that the receiver can be tuned without removing the shield.

INSTALLATION

Install the shield and by-pass capacitors as shown on Installation Diagram B-7489191, which accompanies these instructions.

PARTS LIST

Description	G-E Drawing and Part Number
Capacitor, assembly: Includes ten ceramic capacitors, Hi-K disk; 0.01 mfd +100% -0%, 500 v d-c w; G-E Dwg. and Part No. C-7774750-P13. Includes one ceramic disk capacitor, insulated, temp compensating; 22 mmfd ± 10%, 500 v d-c w; G-E Dwg. and Part No. C-7774846-P13.	PL-7150230-G1

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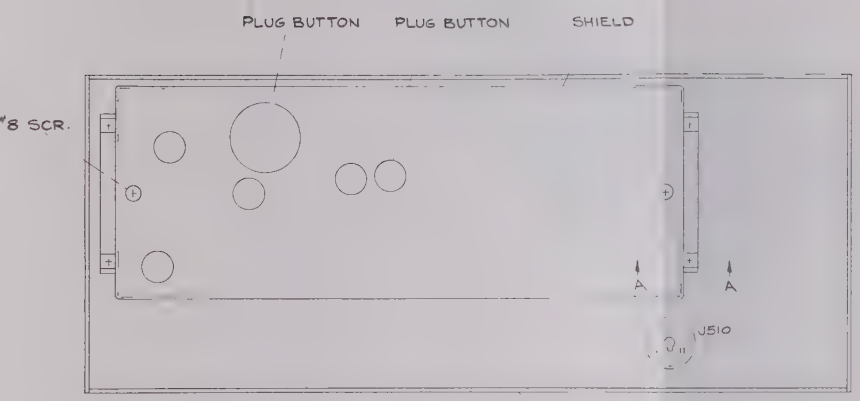
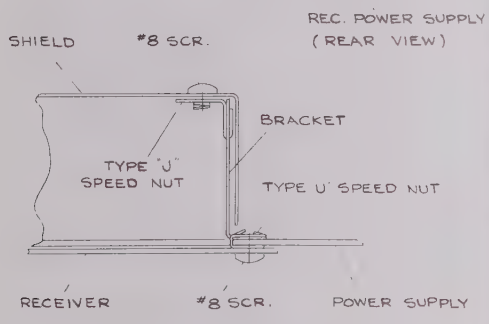




SECTION "A-A"

INSTRUCTIONS

1. REMOVE RECEIVER FROM POWER SUPPLY & DISCARD SPEED NUTS FROM (4) MOUNTING HOLES.
2. ASSEMBLE BRACKETS TO POWER SUPPLY USING TYPE "U" SPEED NUTS SUPPLIED.
3. ASSEMBLE TYPE "J" SPEED NUTS TO BRACKETS.
4. REPLACE RECEIVER USING ORIGINAL MOUNTING SCREWS.
5. ASSEMBLE SHIELD WITH #8 SCREWS SUPPLIED.
6. ASSEMBLE PLUG BUTTONS TO SHIELD.
7. CONNECT A .01 MFD. CAPACITOR, FROM BY-PASS CAPACITOR ASM, TO EACH TERMINAL OF J510, EXCEPT TERMINAL #2.
8. CONNECT THE 22 MFD. CAPACITOR TO J510. TERMINAL #2.
9. SOLDER THE SLEEVING-COVERED BUS WIRE TO THE POWER SUPPLY CHASSIS AS CLOSE TO J510 TERMINAL #6 AS POSSIBLE

NOTE:
1. FOR 4ER2GB RECEIVERS REMOVE AND DISCARD SHIELD ON RECEIVER

Installation Diagram

RECEIVER REAR SHIELD KIT
PL-7144420-G1

(B-7489191, Rev. 3)

PRODUCTION CHANGE SHEET
FOR
TRANSMITTER POWER SUPPLY MODEL 4EP4A3, REV. A

The revision letter appearing on the Power Supply nameplate indicates that all of the following production changes, up to and including that letter, have been made on the unit.

REV. A

Purpose of Change

To help balance voltages across C542-C540B & C541-C540A and to provide better protection against overload in P.A. B+ supply circuit.

Part Changed	Was	Changed To
R591 thru R594	Added.	Resistor, composition: 150,000 ohms ± 10%, 1/2-watt. G-E Part No. C-3R77-P154K.
F502	Fuse: 2-amp at 250v, type 3AG, quick-to-medium blowing. Littelfuse Cat. #312002, Bussman Cat. # AGC-2. G-E Part No. K-1R16-P5.	Deleted.
F505	Added.	Fuse: 1/2-amp at 250v, Type 3AG, quick-to-medium blowing. Littelfuse Cat. #312.500. Bussman Cat. #AGC-1/2 G-E Part No. K-1R16-P1.

Text Change

Description and Maintenance Instructions EBI-41339, under Power Amplifier B-Plus, the following was added; R591 thru R594 provide balance voltages across C504-C - C540-B &

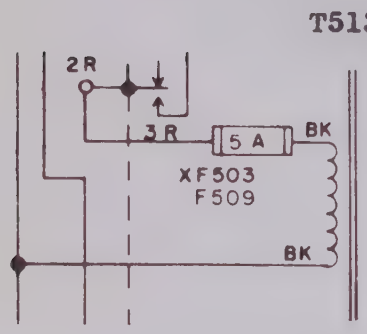
C541 - C540-A. A fuse, F505 provides protection against overload in the Power Amplifier B-Plus circuit.

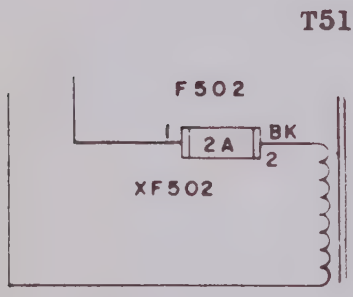
References to F502 were deleted from text.

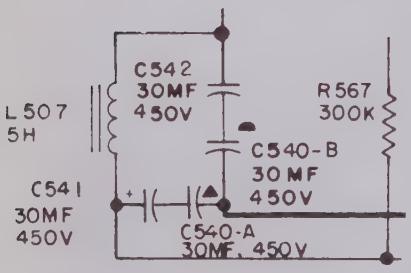
References to F505 were added to text.

Elementary Diagram Changes

Was:







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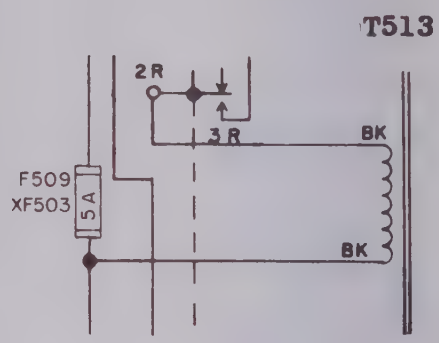

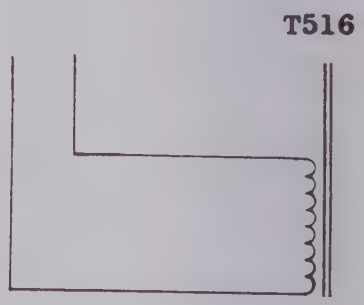

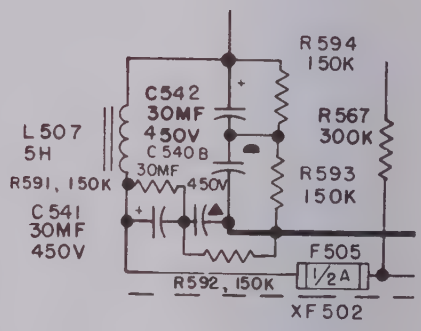

Outline Diagram Changes

Deleted references to F502.

Added F505 - 1/2 Amp.

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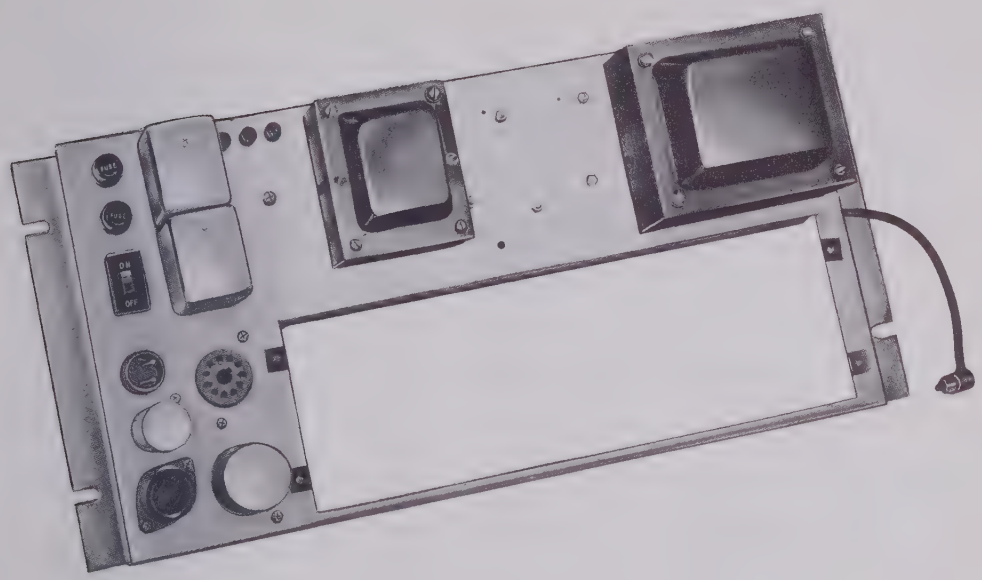
ELECTRONICS PARK

SPECIFICATIONS

CHASSIS PT-6



Type	EP-4-A.
Description	Power supply for station transmitter
Nominal input voltage	117 volts, 50/60 cps.
Maximum power input	When used with: SERIES 17 — STANDBY 42.0 watts — TRANSMIT 320.0 watts SERIES 36 — STANDBY 50.0 watts — TRANSMIT 258.0 watts SERIES 42 — STANDBY 50.0 watts — TRANSMIT 200.0 watts
Output capacity	To transmitter: 660 volts at 285 milliamperes: Series 17 only OR 425 volts at 320 milliamperes: Series 36 OR 425 volts at 150 milliamperes: Series 42 only AND 330 volts at 110 milliamperes 200 volts at 30 milliamperes −25 volts bias at 10 milliamperes 6.3 volts a-c at 6.0 amperes 5.8 volts d-c at 650 milliamperes
Used with	Chassis T-36 (transmitter Type ET-21-A). 144-174 mc Chassis T-16 (transmitter Type ET-23-A). 25-54 mc Chassis T-42 (transmitter Type ET-24-A). 450-470 mc
Rated duty cycle	Continuous: Blower may be required for associated transmitter.
Type of circuit	Full-wave bridge using transformer and high-temperature silicon rectifier cells.
Size	19" long x 8¾" wide x 7¼" high.
Weight	20½ lbs.

SCOPE OF SPECIFICATIONS—In the construction of the equipment described herein, the full intent of the specification will be met. It is assumed, however, that any departure from the specification, desirable for reasons of improved design or operation, will be permissible.

The equipment described above meets or exceeds all applicable EIA (RETMA) specifications.

GENERAL ELECTRIC

COMMUNICATION PRODUCTS DEPARTMENT

MOUNTAIN VIEW ROAD • LYNCHBURG, VA.

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DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR STATION TRANSMITTER POWER SUPPLY MODEL 4EP4A2, 3

General Electric Station Transmitter Power Supply Models 4EP4A2, 3 have been designed for use with Progress Line transmitters in standard 19-inch, rack-mounted installations. The transmitter mounts on the power supply chassis and makes all connections through plug and cable connections to the power supply. This permits rapid replacement of the transmitter, using only a screwdriver to make the change. Jacks are provided for metering the transmitter B-plus voltages. The ON-OFF switch, fuses F509 and F502 and a microphone jack, J506, are located on the front of the power supply chassis. Components and wiring points on the power supply are fully accessible for servicing.

For continuous operation of the transmitter, a blower, mounted on the power supply chassis, provides forced-air cooling for the transmitter PA tubes. The blower is supplied as a part of the Blower Kit for station combinations.

CARBON MICROPHONE MODIFICATION

The following modification should be made if the customer desires to use a carbon microphone with the transmitter instead of a controlled-reluctance microphone.

1. Add a piece of .025-inch bus wire with sleeving between J509-2 and terminal 5 of terminal board TB5.

2. Remove the lettering "DYN" over the microphone receptacle.

3. Stamp "M9" in the OPTION pad on the Transmitter Power Supply nameplate.

MAINTENANCE

To obtain optimum performance from the equipment, a program of regular preventive maintenance should be followed. This preventive maintenance should include the following.

1. A mechanical inspection of the unit for loose, broken or damaged components.

2. An inspection of the power-control cable connection to the transmitter.

3. A check of the input voltage.

4. Measurement of the transmitter B-plus voltages at the "LV-B+" jack, M505 (red-positive), and at the "HV" jack, J507 (red-positive). A 1-volt deflection on a 20,000 ohm-per-volt voltmeter at J505 indicates a B-plus reading of 100 volts. A 1-volt deflection at J507 indicates 300 volts of B-plus.

5. Blower and relay maintenance as described below.

BLOWER

If a blower has been installed on the power supply chassis to cool the transmitter PA tubes, it should be cleaned periodically to maintain its efficiency. The frequency of cleaning will depend upon the average amount of dust in the air near the transmitter, the percentage of time the transmitter is in operation and whether the blower operates continuously or only when the transmitter is keyed.

Unless the impeller blades have become coated with oil, the dust which collects on them can be loosened with a small, stiff brush and removed with a vacuum hose to prevent its being blown into the transmitter. If a source of high pressure compressed air is available, the blower may be removed from the power supply chassis and the dust blown out. Check to see that the PA housing is also free from dust.

If the impeller blades have become coated with oil, they should be removed, washed in grease solvent and hot water, dried thoroughly and replaced.

The frequency of oiling the blower bearings also depends upon how much the blower is used. When running continuously, the bearings should be oiled about once every three months. Since the bearings are impregnated with "Gulfcrest C" oil, use the same grade of oil for reoiling. This oil is sold as Gulf Electric Motor Oil in 4-ounce cans or gallon containers. Blowers operating in locations having an unusually high ambient temperature must be oiled somewhat more frequently. Do not allow oil to get onto the impeller blades.

RELAYS

The relays in these units require little care. However, they should be inspected periodically to assure maximum operating efficiency. If the contacts become pitted, they should

be cleaned with a burnishing tool to smooth out any metallic deposits. When relay contacts carry little or no current, the contacts do not clean themselves and an insulating coating is apt to form. This coating may be removed by cleaning the contacts with a burnishing tool. Do not oil the relay bearings. When relays are in dusty locations, lubricated bearings will collect dust and grit and will wear more rapidly than nonlubricated bearings. Some of the relays used are of the multiple-contact type and, in the unenergized position, should have contact spacings of approximately .1625 to .125 inch. More important, the contact spacings on any multiple-contact relay should be equal so that the contact pressures will be equal when the relay is energized. The back pressure of the antenna relay should be at least 15 grams. Low back pressure will shorten the life of contacts, due to excessive arcing, and may also cause noise in the receiver, due to chatter of the antenna relay contact under vibration.

CIRCUIT ANALYSIS

Station Transmitter Power Supply Model 4EP4A2, or 4EP4A3 supplies all operating voltages for the station transmitter and mounts the transmitter chassis in standard 19-inch racks. All connections to the transmitter are made through plug cable connections to the power supply.

The 117-volt a-c input to the station is connected across terminals 9 and 10 of TB502. The station interlock switch, connected between terminals 10 and 11, interrupts the input voltage, if the rear door of the cabinet is opened, to protect service personnel from high voltages. With the door closed, turning the ON-OFF switch (S502 on Model 4EP4A2 and S503 on Model 4EP4A3) to the ON position applies power to the primary of power transformer T506. On Model 4EP4A3 a second set of contacts on the ON-OFF switch (S503) provides interlocking for LB+ and filament circuits if desired.

The BR-BR secondary winding of T506 (4EP4A2) or T515 (4EP4A3) (brown lead to brown lead) provides 6.3 volts a-c for the transmitter's filaments and for control uses. The a-c voltage across the G-G secondary is rectified by full-wave bridge rectifier CR510 to provide relay-energizing voltage.

OSCILLATOR AND MULTIPLIER B-PLUS

B-plus voltages for the oscillator and multiplier stages of the transmitter are obtained by rectifying the a-c voltage developed across the R-R winding of T506 or T515. Rectification is provided by full-wave rectifier bridge CR529 thru CR536

and filtering by capacitor C502-A, C and D, resistors R528 and R529 on the Model 4EP4A2 and resistors R586, R587 and R529 on the Model 4EP4A3. R534 is a bleeder resistor.

NEGATIVE BIAS

The a-c voltage across the Y-Y secondary winding (yellow lead to yellow lead) of transformer T506 or T515 is rectified by half-wave rectifier CR537 and filtered by CR511 to supply negative bias for the transmitter fourth multiplier and power amplifier control grids. This negative bias is present as a protective measure to limit cathode current in the PA tube when the PA is untuned. R509 in the bias supply is a surge resistor.

POWER AMPLIFIER B-PLUS

A separate transformer, T513, which operates only when the transmitter is keyed, is provided to furnish B-plus voltage for the power amplifier stage of the transmitter. The R-RY section of the secondary winding of T513 is used for 144-174 Mc Transmitter Type ET-21-A. For 25-54 Mc Transmitter Type ET-23-A, the full R-RBK section of the secondary is used for 100-watt operation, or the R-RY section is used for 50-watt operation. 100-watt operation of Transmitter Type ET-23-A requires the use of blower kit PL-7146797-G1. The R-RG section of the secondary is used for 450-470 Mc Transmitter Type ET-24-A. The high voltage across the secondary is rectified by a full-wave rectifier bridge consisting of CR517 thru CR528 and is filtered by capacitors C540A, C540-B and C502-B and by the choke L507. R591 thru R594 provide balance voltages across C504-C540B and C541-C540A. A fuse F505 provides protection against overload in the Power Amplifier B-Plus circuit.

RELAY CIRCUITS

Keying the transmitter energizes Pilot Relay K506, which initiates the sequence of operation outlined on the following page:

PILOT RELAY K506	ANTENNA RELAY K102
K506-2L,3L close, energizing antenna relay K101 (in transmitter), control relay K507 and receiver mute relay K509 (in receiver)	K101 energizes, switching antenna from receiver to transmitter.
K506-2R,3R close, applying B-plus voltage to transmitter oscillator and modulator stages.	RECEIVER MUTE RELAY K509
K506-5L,6L close, applying B-plus voltage to transmitter multiplier stages.	K509 energizes, muting receiver.
K506-4R,5R close, starting blower motor (if used,) and if not connected to operate continuously.	CONTROL RELAY K507
	K507-4R,5R and 2R,3R close, applying 117 volts across T513 primary to supply B-plus voltage for transmitter PA.
	K507-5L,6L close, lighting TRANSMIT lite on control unit.
	K507-1L,3L (Model 4EP4A3 only) open ungrounding the transmitter PA screen.

METERING CIRCUITS

Three metering jacks, the "HV" jack (J507), the "LV-B+" jack (J505) and the "GND" jack (J508), are provided on the power supply chassis to facilitate measuring the transmitter B-plus voltages. All readings are those read on a 20,000 ohm-per-volt voltmeter.

The voltage read at the "LV-B+" jack (J505) must be multiplied by 100 to obtain the actual voltage across metering resistors R513 and R514.

The "HV" jack (507) has been provided for metering the B-plus voltage on the transmitter PA tubes. The meter reading must be multiplied by 300 to obtain the actual B-plus voltage across metering resistors R567, R511 and R512. These resistors also serve as bleeders.

AUDIO CIRCUITS

Resistors R530 and R531 are impedance-matching resistors used to match the audio input to the transmitter first audio. C509 is a d-c blocking capacitor. For intercommunication over phone lines between the transmitter and the control unit location, microphone current for a carbon microphone is obtained from the negative bias section of the power supply through current-limiting resistor R533. R532 is a line-matching resistor and C511 is provided for audio return.

BLOWER KIT

For continuous operation of the station transmitter, a blower is mounted on the power supply chassis to provide forced-air cooling for the transmitter PA tube(s). The blower connects to terminals 1 and 3 of TB503 on the power supply. If it is desired to have the blower operate only when the transmitter is keyed, instead of continuously, the jumper between terminals 2 and 3 of TB503 should be removed.

CARBON MICROPHONE MODIFICATION

Although a controlled-reluctance microphone is normally supplied with the Progress Line Mobile Combinations, a simple modification, described earlier in this EBI, permits the use of carbon microphone. Microphone Current is obtained from the negative bias circuit in the power supply.

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LYNCHBURG, VIRGINIA

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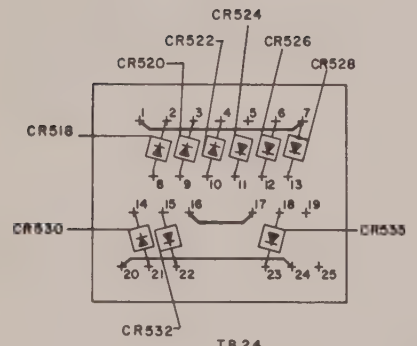
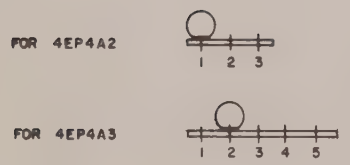
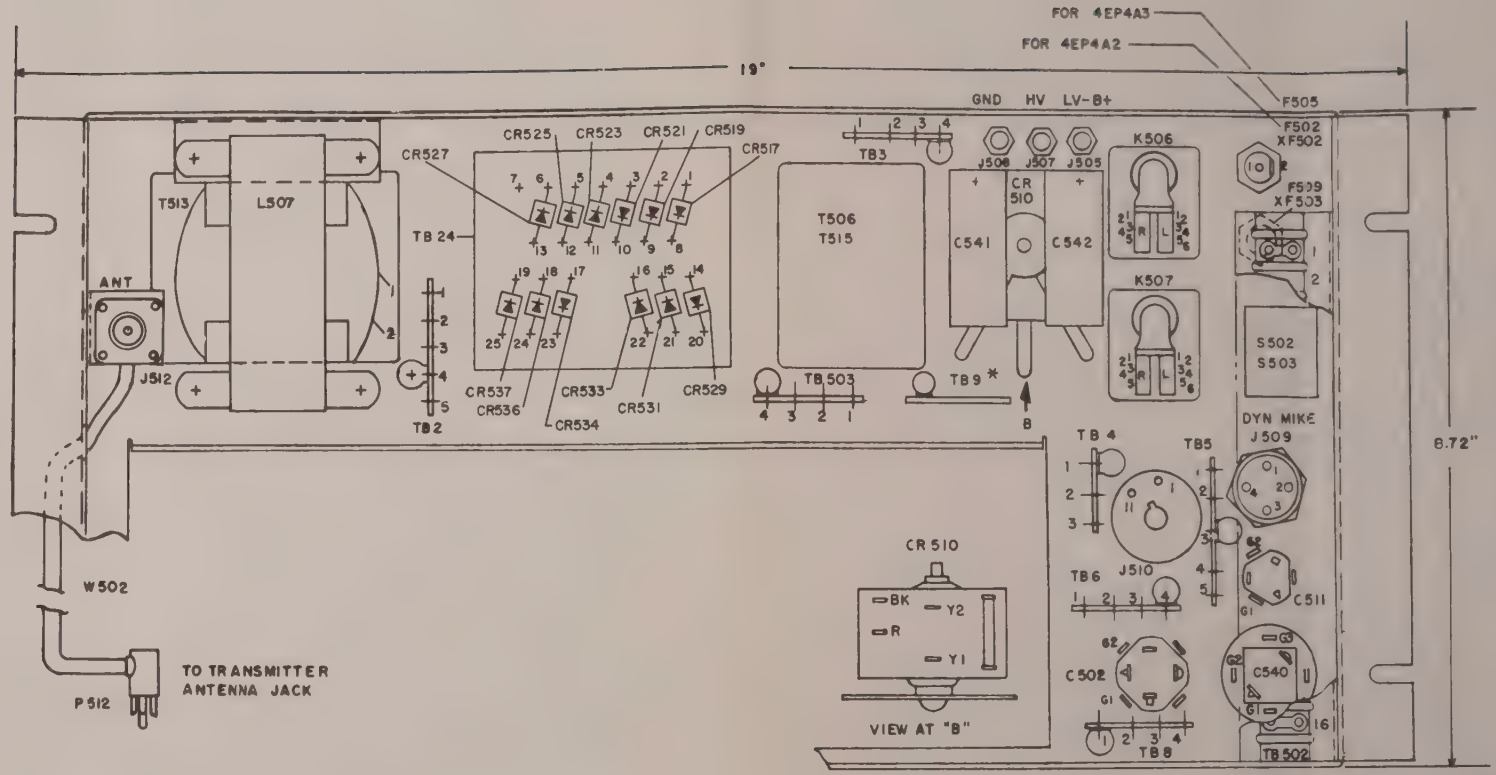




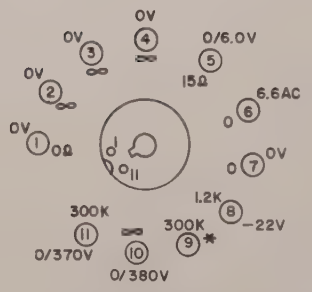
* TERMINAL NUMBERING FOR TB9



METER READINGS AT TB502

NO	VOLTAGE	RESISTANCE
1	0	∞
2	−22	30
3	8.0/0	70K
4	0	∞
5	380	150K
6	0	∞
7	0	0
8	6.6 AC	0
9	—	—
10	—	—
11	—	—
12	0	∞
13	0	∞
14	0/6.0	15
15	0	∞
16	0	∞

COMBINATION NUMBER	PO 17 VO 17 DO 17	PO 16 PO 36 VO 16 VO 36 VO 18 VO 38 DO 16 DO 36	PO 42 VO 42 DO 42	
TRANSMITTER TYPE	ET-23-A	ET-21 & 23-A	ET-24-A	
RF POWER	100 W	50 W	12 W	
J510-9 * METER READING	810 V	530 V	510 V	



METER READINGS AT J510

METERING JACK		1 VOLT DEFLECTION ON A 20,000 OHM-PER-VOLT VOLTMETER EQUALS
LV-B+	J505	100 VOLTS
HV	J507	300 VOLTS

△ ON CR506, CR507, CR515 & CR516 CHANGE R TO BK & BK TO R FOR 4EP4A3.

CONDITIONS OF MEASUREMENT:

1. ALL MEASUREMENTS MADE FROM INDICATED POINT TO CHASSIS WITH ALL CABLES DISCONNECTED FROM UNIT.
2. VOLTAGES ARE TYPICAL READINGS ON A 20,000 OHM-PER-VOLT DC METER, UNLESS OTHERWISE NOTED, WITH 117 VOLTS AC APPLIED BETWEEN PINS 9 AND 11 OF TB502.
   A- READINGS FOLLOWED BY "AC" WERE OBTAINED WITH A 1000 OHM-PER-VOLT AC VOLTMETER.
   B- WHERE TWO VOLTAGES ARE GIVEN FOR ONE POINT (I.E. 0/6.0 V), FIRST READING IS FOR "STANDBY" AND SECOND IS FOR "TRANSMIT." POWER SUPPLY CAN BE KEYED BY GROUNDING PIN 3 OF MICROPHONE JACK J509.
3. ALL MEASUREMENTS MADE WITH A METER RANGE THAT GIVES ONE-THIRD TO FULL-SCALE DEFLECTION OF THE METER.
4. ALL DC VOLTAGES ARE POSITIVE WITH RESPECT TO CHASSIS, UNLESS MARKED "−" FOR NEGATIVE.
5. RESISTANCES ARE TYPICAL READINGS WITH ALL VOLTAGES REMOVED.

Service Outline

STATION TRANSMITTER
POWER SUPPLY MODELS
4EP4A2 & 3

(D-5497691, Rev. 5)

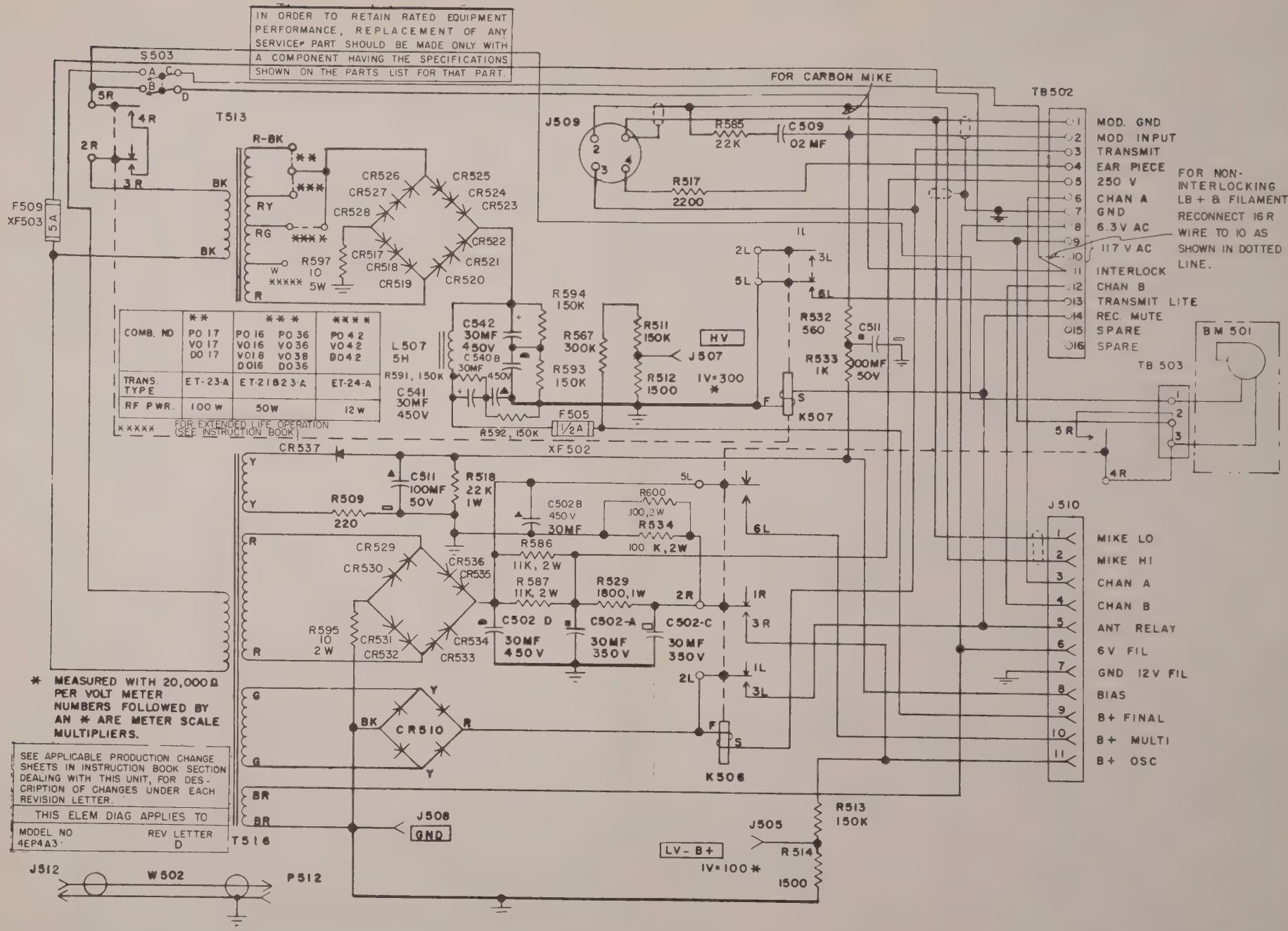
HINTS FOR SERVICING

The following list of service hints, in addition to the table of Typical Metering Voltages and the Voltage-Resistance Chart (see reverse side of page) will assist the serviceman in locating the source of trouble if the Power Supply Should fail to operate properly.

SYMPTOM	SERVICE HINTS
Transmitter completely dead.	Check line voltage at terminals 9 and 11 of TB502.
	Check power fuse F502 (2-amp).
	Check output voltages at J510 with those listed on reverse side of page.
Transmitter filaments lit, but no power output.	Check HV-B+ fuse F509 (5-amp).
Low B-plus (HV).	Open rectifier (CR513,CR514,CR515,or CR516).
Low B-plus (LV).	Open rectifier (CR506 or CR507).

TYPICAL METERING VOLTAGES

METER JACK	CIRCUIT	MULTIPLIER METER READING BY	VOLTAGE
LV-B+ J505	Oscillator and Multiplier B-plus	100	200 volts
HV-B+ J507	Power Amplifier B-plus	300	420 volts (144-174 MC and 450-470 MC band)
			660 volts (25-54 MC band)



Elementary Diagram

TRANSMITTER POWER SUPPLY
MODEL 4EP4A3, REV. D

(C-5494811, Rev. 8)

PARTS LIST

TRANSMITTER POWER SUPPLY MODEL 4EP4A3, REV. D

PL-7774169-G21

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	CAPACITORS	
C502	Electrolytic, polarized, twist prong base; 30-30-30-30 mfd, 450-350-450-350 v d-c w. Mallory Type FP.	P-7772415-P46
C509	Ceramic, insulated, miniature. Hi-K disk; 0.02 mfd +60% -40% at 25°C, 250 v d-c w.	B-7487478-P3
C511	Electrolytic, non polarized, twist prong base; 100-100 mfd +250% -10%, 50-50 v d-c w.	C-7775492-P1
C540	Electrolytic, polarized, twist prong base, with insulating sleeve; 30-30 mfd +50% -10%, 450-450 v d-c w. Mallory Cat. #FP-237.	B-7772471-P14
C541 and C542	Electrolytic, tubular; 30 mfd +50% -10%, 450 v d-c w. PR Mallory Cat. #TC-77.	C-7774786-P44
	RECTIFIERS	
CR505#	Selenium, 1 cell, forward current 150 ma, peak inverse 64 V. G-E Cat. #6RS21PH1AT1. Deleted by Rev. B.	A-7140806-P1
CR506# and CR507#	Selenium, 24 cells in stack, forward current 120 ma, for units connected as a full wave bridge, use 1/2 this rating for half wave or doubler operation, peak inverse 380 v per ARM, connected for doubler. G-E Cat. #6RS21PD12BB1. Deleted by Rev. B.	A-7144141-P2
CR510	Selenium, 4 cells in stack, approx d-c output with aged stack 18 V, forward current or d-c output 1.25 amp, max peak inverse or peak a-c input 37 V. G-E Cat. #6RS25GB1BA1.	B-7488065-P1
CR513# thru CR516#	Selenium, half wave; forward current 0.150 amp d-c input 650 V RMS forward drop 15.5 V RMS, reverse current 24.0 ma RMS. G-E Cat. #6RS22PH14BAD1. Deleted by Rev. B.	B-7489163-P2
CR517# thru CR537#	Silicon rectifier, half wave; peak volts 400, capacitive load, inverse 300, resistive load 500 ma. Similar to Westinghouse 1N1169. Added by Rev. B.	B-5490415-P2
	FUSES	
F502#	Deleted by Rev. A.	
F505#	Fuse; 1/2 amp at 250 V, type 3AG, quick to medium blowing. Littelfuse Cat. #312.500. Bussman Cat. #AGC-1/2. Added by Rev. A.	K-1R16-P1
F509	Slow blow, Type 3AG, 5 amp at 125 v. Littelfuse Cat. #313005. Bussman Cat. #MDX-5.	B-7478924-P19
	JACKS AND RECEPTACLES	
J505	Test point jack, phenolic or urea. Alden Products Co. Type 110BCS-red.	A-7143966-P2
J507	Test point jack, phenolic or urea. Alden Products Co. Type 110BCS-red.	A-7143966-P2
J508	Test point jack, phenolic or urea. Alden Products Co. Type 110BCS-black.	A-7143966-P1
J509	Chassis connector; 4 female contacts. Amphenol Type 91-PC4F.	K-7117934-P2
J510	Connector and ring; 11 female contacts, mica filled phenolic. Cinch Cat. #13786.	A-7140824-P2
J512	Jack, part of cable W502.	
	RELAYS	
K506 and K507	Resistance 28 ohms ± 10%, pick up 4.5 v d-c or less, operate 7.2 v d-c or less, single 1 form A, 3 form C contacts. Contact pressure 25 gms min. Potter Brumfield Cat. #MJ-1195.	C-7774180-P6
	INDUCTOR	
L507	Reactor: inductance 5 h at 0.3 amps d-c, d-c resistance 80 ohms max, peak a-c ripple 100 v at 120 cycle, operating 1000 v d-c.	B-5490104-P1
	PLUG	
P512	Plug, part of cable W502.	
	RESISTORS	
R509	Composition, 220 ohms ± 10%, 1 w.	C-3R78-P221K
R511	Composition, 0.15 megohm ± 5%, 1/2 w.	C-3R77-P154J
R512	Composition, 1500 ohms ± 5%, 1/2 w.	C-3R77-P152J
R513	Composition, 0.15 megohm ± 5%, 1/2 w.	C-3R77-P154J
R514	Composition, 1500 ohms ± 5%, 1/2 w.	C-3R77-P152J
R517	Composition, 2200 ohms ± 10%, 1/2 w.	C-3R77-P222K
R518	Composition, 22,000 ohms ± 10%, 1 w.	C-3R78-P223K
R529	Composition, 1800 ohms ± 10%, 1 w.	C-3R78-P182K
R532	Composition, 560 ohms ± 10%, 1/2 w.	C-3R77-P561K
R533	Composition, 1000 ohms ± 10%, 1/2 w.	C-3R77-P102K
R534*	Composition, 100,000 ohms ± 10%, 2 w. Changed by Rev. D.	C-3R79-P104K
R567	Composition, 0.30 megohm ± 5%, 1/2 w.	C-3R77-P304J
R585	Composition, 22,000 ohms ± 10%, 1/2 w.	C-3R77-P223K
R586 and R587	Composition, 11,000 ohms ± 10%, 1/2 w.	C-3R79-P113K
R591# thru R594#	Composition, 0.15 megohm ± 10%, 1/2 w. Added by Rev. A.	C-3R77-P154K
R595	Composition, 10 ohms ± 10%, 2 w. Added by Rev. B.	C-3R79-P100K
R596	Wirewound, 10 ohms ± 10%, 5 w. Omit wire leads. Added by Rev. B.	B-7487415-P109
R600#	Composition, 100,000 ohms ± 10%, 2 w.	C-3R79-P104K
	SWITCH	
S503	Toggle type, dpst, 10 amp at 250 v, 15 amp at 125 v, 60 cycles. Hart Mfg. Co. Cat. #2160A.	A-7143613-P1
	TRANSFORMERS	
T513	Power, rectifier, single phase. Pri: 117 v, 50/60 cycles; sec #1: 545/375/350 v, 0.575/0.595/0.385 amps.	B-5490007-P1
T516	Filament and rectifier, single phase. Pri: 117 v, 50/60 cycles; sec #1: 270 v, 0.210 amp; sec #2: 18.0 v, 0.054 amp; sec #3: 9.0 v, 1.85 amp; sec #4: 6.3 v, 12.0 amp.	B-7487265-P2
	CABLE	
W502	Cable assembly; includes connector, chassis receptacle. Amphenol Cat. #83-1R. Signal Corp. #SO-239. G-E Dwg. and Part No. M-2R22-P3. Hood Type UG-177/U similar to Amphenol Cat. #83-765. G-E Dwg. and Part No. K-7114629-P1 and a cable assembly of 15.50" long of RG-58/U cable with a short pin silver plated phone plug molded on one end. Color black. G-E Dwg. and Part No. B-7488600-P91.	A-7146725-G3
	SOCKETS	
XF502 and XF503	Fuse holders. Bussman Mfg. Type HKP.	K-7115179-P1

INSTRUCTIONS FOR BLOWER KIT PL-4031701-G1 AND G2

Description	Page 1
Installation	Page 1
Parts List	Page 2
Installation Diagram	B-5490830

DESCRIPTION

Blower Kit PL-4031701-G1 is required for use with Transmitter Type ET-21-A and Blower Kit PL-4031701-G2 is required for use with Transmitter Type ET-23-A or ET-24-A if the transmitter is to be rated for continuous duty. The blower mounts on the chassis of Power Supply EP-4-A and directs its air stream onto the PA tube(s) of the transmitter. Maintenance instructions for the blower are included in the instructions for the power supply.

INSTALLATION

1. If the Blower Kit is to be used with Transmitter Type ET-21-A, remove the perforated shield over the Transmitter's PA tubes and replace it with the shield supplied with the Blower Kit. (See Installation Diagram B-5490830, which follows.) The remaining section of the PA housing is perforated to allow the air from the blower to escape after it has cooled the PA. Early models of Transmitter ET-21-A, however, lacked perforations in this portion of the PA housing. If the Blower Kit is used with one of these transmitters, the PA housing should be replaced either by PL-7775576-G1 (for Transmitter Model 4ET21A2 or 12) or PL-7775576-G3 (for Transmitter Model 4ET21A1 or 11), which includes both the shield and the electrical components mounted inside it, or by PL-7488594-G1, which includes only the perforated metal shield.

2. Install the blower on the Power Supply chassis as shown on Installation Diagram B-5490830, which follows.

3. Pass the wires from the blower through hole H1 in the Power Supply chassis, connect one wire to TB503-1 and connect the other wire to TB503-3.

4. If it is desired to have the blower operate only when the transmitter is keyed, rather than continuously, remove the jumper from between terminals 2 and 3 of terminal board TB503.

PARTS LIST

Symbol	Description	G-E Drawing & Part Number
BM501	Blower Motor: clockwise rotation, single phase, continuous duty, 115 v, 60 cps at 65 watts. Similar to Ripley Model 81-#2 3/4 L-R.	B-5490817-P1

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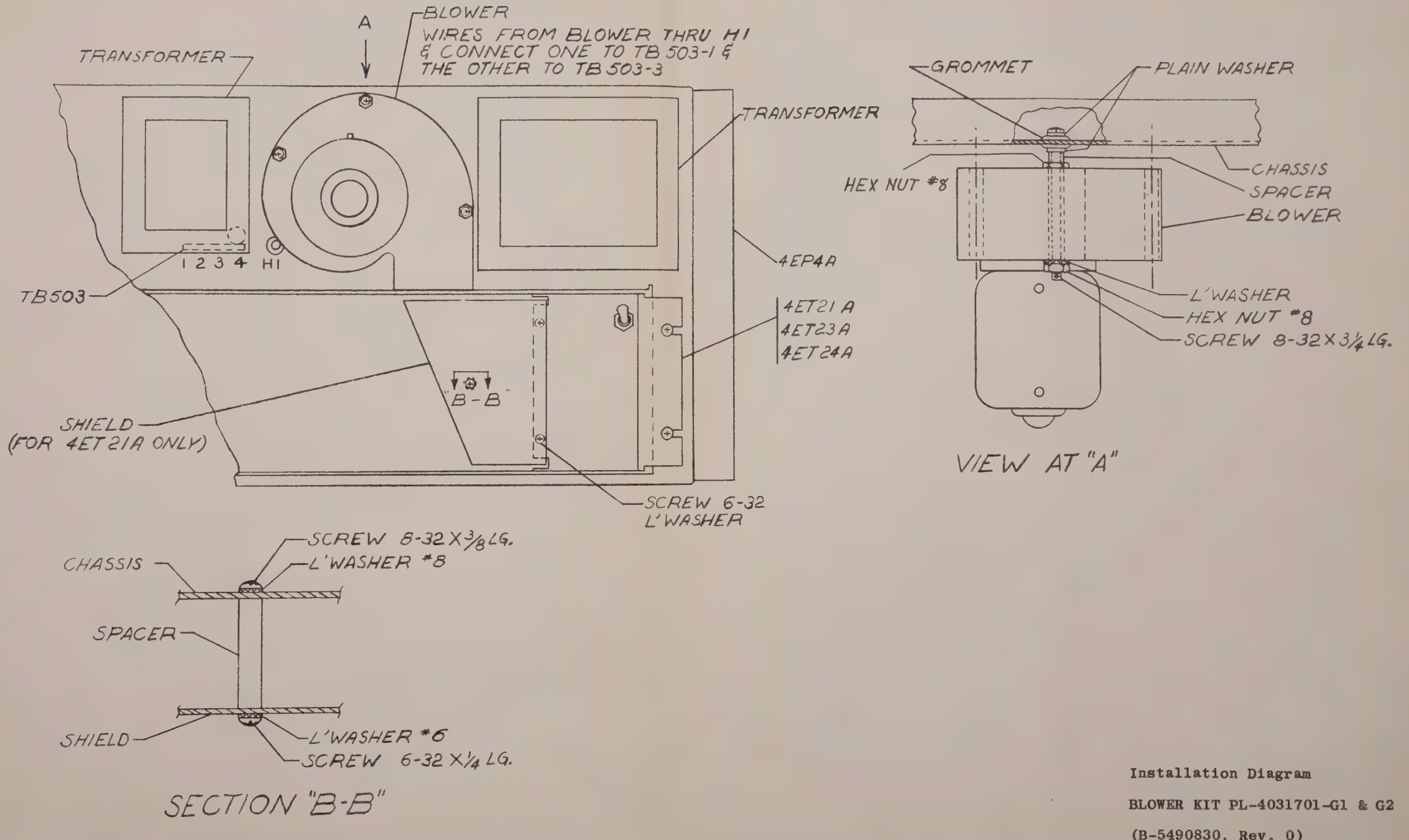


Installation Diagram

BLOWER KIT PL-4031701-G1 & G2

(B-5490830, Rev. 0)

PRODUCTION CHANGE SHEET
FOR
RECEIVER POWER SUPPLY MODEL 4EP3A1, REV. E

Changes listed below are identified by the letter appearing in the REV. pad.

REV. A

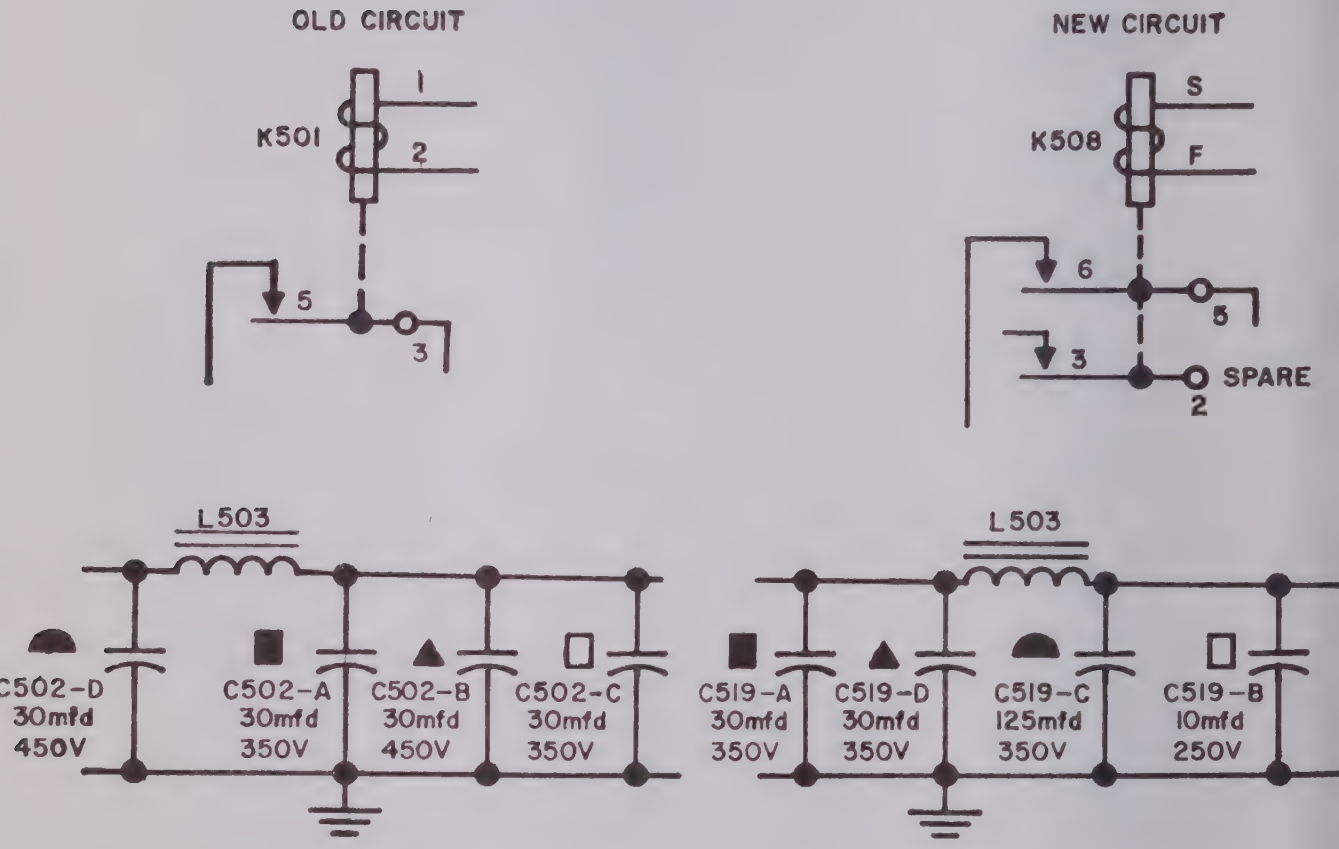
Part Changed	Was	Changed To
C502	Capacitor: electrolytic polarized twist prong base, 30/30-30-30 mfd, 450/350-350-350 v d-c w. Mallory Type FP, G-E Dwg. P-7772415-P46.	Replaced by C519.
C519	Added in place of C502.	Capacitor: electrolytic, polarized, twist prong base, 4-section 125-30-30 mfd +100% -10%, 350-350-350 v d-c w/10 mfd +100% -10%, 250 v d-c w. Mallory Type FP. G-E Dwg. C-7770994-P48.
K501	Relay: coil operating range 4.9 to 6.9 v d-c, resistance 50 ohms ± 10% at 25°C, spdt contacts. G-E Dwg. K-7127542-P2.	Replaced by K508.
K508	Added in place of K501.	Relay: miniature, resistance 30 ohms ± 10% at 25°C, pick-up 3 v d-c or less, operate 6.5 v d-c max, contacts 2 form A, 3 amp at 115 v a-c, non-inductive.Price Elec. Type #1054-4. G-E Dwg. B-7489216-P1.

Text Changes

Change references to C502 and K501 to C519 and K508 in text and on Service Outline.

Elementary Diagram Changes

Change Elementary Diagram as shown below:



REV. B

Part Changed	Was	Changed To
K508	Relay: miniature, resistance 30 ohms ± 10% at 25°C, pick-up 3 v d-c or less, operate 6.5 v d-c max, contacts 2 form A, 3 amp at 115 v a-c, non-inductive. Price Elec. Type #1054-4. G-E Dwg. B-7489216-P1.	Replaced by K509.
K509	Added in place of K508.	Relay: miniature, resistance 19 ohms ± 10% at 25°C, pick-up 3 v d-c or less, operate 6.5 v d-c max, 2 form C, 3-amp at 115 v a-c, non-inductive contacts. Price Elec. Type #1051-16. G-E Dwg. B-7489216-P2.
R565	Added.	Resistor: composition, 47 ohms ± 10%, 1/2 w. G-E Dwg. C-3R77-P470K.

Text Changes

The receiver is now muted during transmissions by K509, which removes receiver B-plus when energized, instead of by K508, which shorted out the VOLUME control when energized.

Service Outline Change

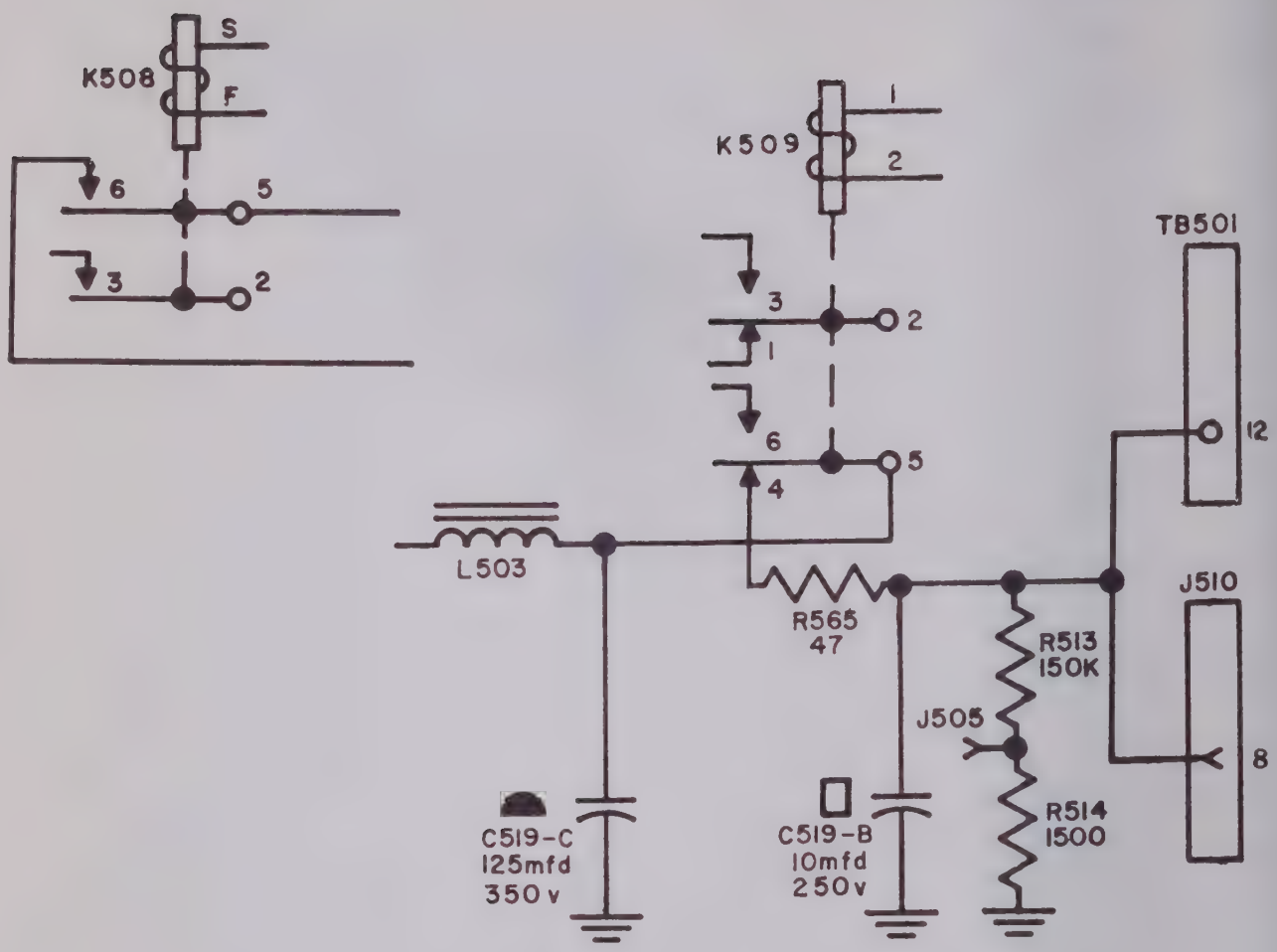
K508 was changed to K509.

Elementary Diagram Changes

Change Elementary Diagram as shown below:

OLD CIRCUIT

NEW CIRCUIT



REV. C

Part Changed

None.

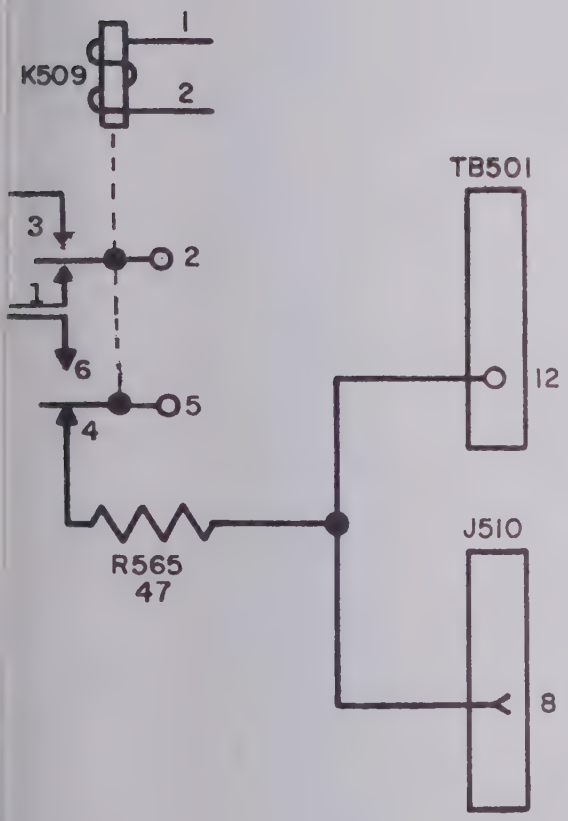
Text Change

None.

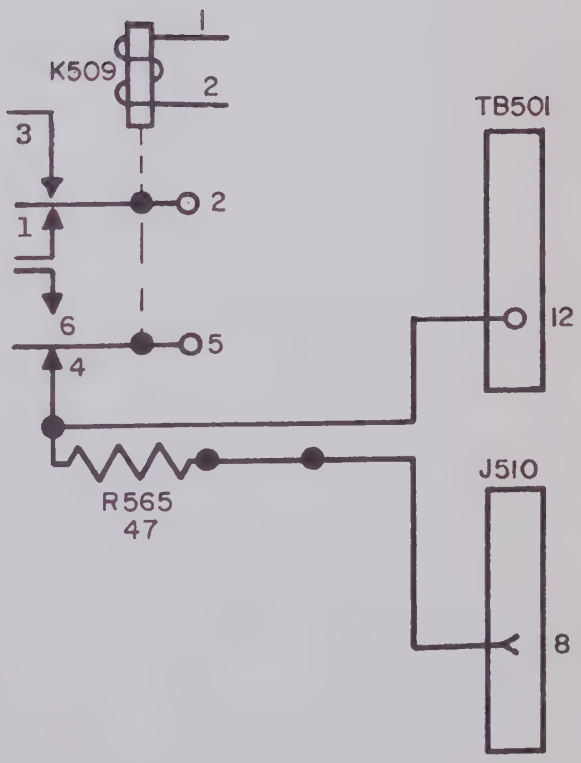
Elementary Diagram Change

Change Elementary Diagram as shown below:

OLD CIRCUIT



NEW CIRCUIT



REV. D provides better power output capabilities and provides better protection for transformer and rectifiers.

Part Changed	Was	Changed To
T504	Transformer: Filament and Plate. Pri: 117 v ± 10%, 60 cycles; sec #1: 6.3 v, 5.5 amp; sec #2: 176 v, 0.145 amp; sec #3: 9.3 v, 0.500 amp. G-E Dwg. No. B-7487217-P1.	Deleted.
T515	Replaces T504.	Transformer: Filament and Rectifier, single phase, Pri: 117 v, ± 10%, 50/60 cycles; sec #1: 186 v, 0.215 amp; sec #2 6.0 v, 8.0 amp. G-E Dwg. No. B-5490235-P1.
F501	Added.	Fuse: 1/8 amp at 250 v, type 3AG quick to medium blowing. Littelfuse Cat. #312.125, Bussman Cat. #AGC-1/8. G-E Dwg.No. K-1R15-P12.

Text Changes

Changed reference to T504 to T515 in text.

Service Outline Changes

Added F501, XF501, 1/8A and T515.

Elementary Diagram Changes

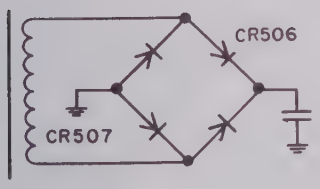
Deleted T504 and added T515. Added F501, XF501, 1/8-amp between J510-8 and R565, 47 ohms.

REV. E - To improve reliability by using high quality silicon rectifiers.

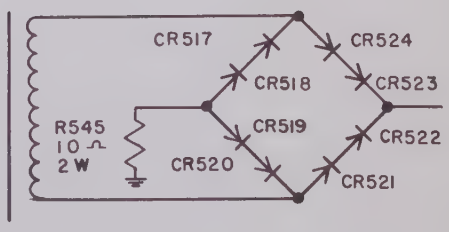
Part Changed	Was	Changed To
CR506 and CR507	Rectifier; selenium, forward current 120 ma, peak inverse 750 v per arm, connected for doubler. G-E Cat. #CRS21PD12BB1. G-E Dwg. No. A-7144141-P2.	Replaced by CR517 thru CR524.
CR517 thru CR524	Added in place of CR506 and CR507.	Rectifier: silicon, half-wave, peak volts 400, capacitive load inverse 300, resistive load 500 ma. Similar to Westinghouse 1N1199. G-E Dwg. No. B-5490415-P2.
R595	Added.	Resistor: composition, 10 ohms ± 10%, 2 w. G-E Part No. C-3R79-P100K.

Elementary Diagram Changes:

Was:



Changed To:



REV. E (Cont'd)

Outline Diagram Changes

Added Silicon Rectifiers in place of selenium rectifiers.

Text Changes

References to CR506 and CR507 were changed to CR517 thru CR524.

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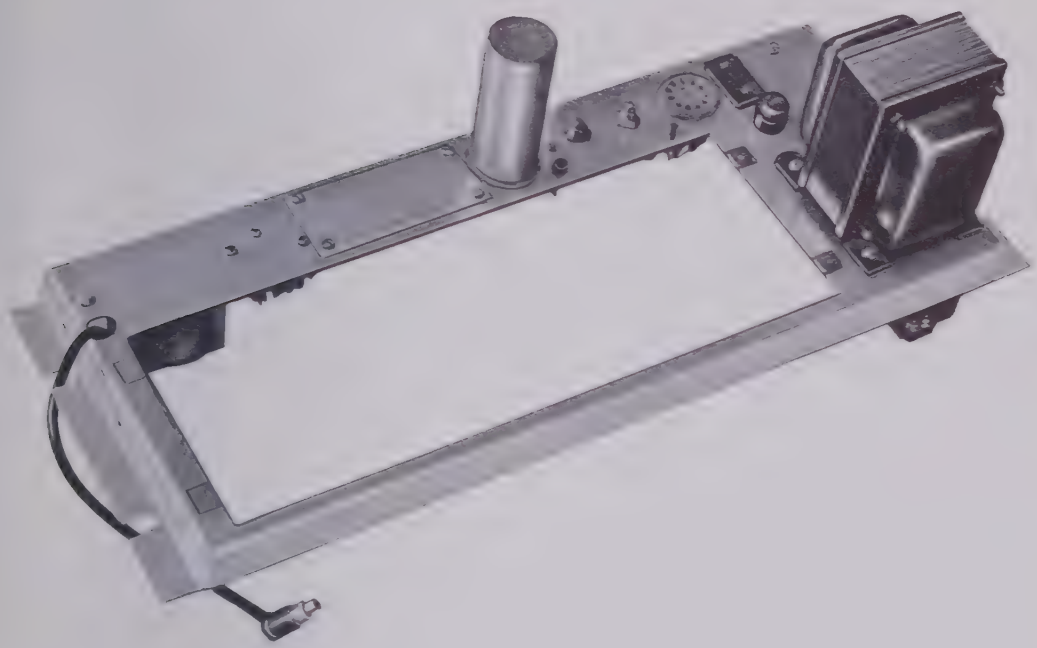
OGRESS LINE

COMMUNICATION EQUIPMENT

SPECIFICATIONS

CHASSIS PR-6



Type	EP-3-A	**Rated duty cycle**	Continuous.
Description	Station power supply for progress line receiver	**Size**	19" long x 7" wide x 6¾" high.
Nominal input	117 volts 50/60 cps. 50 watts	**Weight**	9 lbs.
Type of circuit	Full-wave bridge using transformer and hermetically sealed silicon rectifier cells.		
Maximum Output	6.3 volts a-c at 8.0 amperes 200 volts d-c at 120 milliamperes		

Mounting space for a carrier operated relay is provided.

COPE OF SPECIFICATIONS—In the construction of the equipment described herein the full intent of the specification will e met. It is assumed, however, that any departure from the specification desirable for reasons of improved design or operation. ill be permissible.

he equipment described above meets or exceeds all applicable EIA specifications.

GENERAL ELECTRIC

COMMUNICATION PRODUCTS DEPARTMENT

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DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR STATION RECEIVER POWER SUPPLY MODEL 4EP3A1

General Electric Station Receiver Power Supply Model 4EP3A1 has been designed for use with Progress Line Receivers in standard 19-inch, rack-mounted installations. The receiver mounts on the Power Supply chassis and makes all connections through plug and cable connections to the power supply. This permits rapid replacement of the receiver, using only a screw driver to make the change. Jacks are provided for metering the receiver B-plus voltage and the voltage across the receiver output. The receiver SQUELCH and VOLUME controls are also included on the chassis. Components and wiring points on the power supply are fully accessible for servicing.

MAINTENANCE

To obtain optimum performance from the equipment, a program of regular preventive maintenance should be followed. This preventive maintenance should include the following:

1. A mechanical inspection of the unit for loose, broken or damaged components.

2. An inspection of the power-control cable connection to the receiver.

3. A check of the input voltage.

4. Measurement of the receiver B-plus voltage at the "B+" jack, J505. The average reading should be approximately 200 volts. A reading lower than 185 volts, however, indicates a defect in the power supply.

5. Check to see that fuse F502 is not larger than the specified size (2-amp, type 3AG).

6. Check to see that fuse F501 is not larger than the specified size (1/8-A, type 3AG).

CIRCUIT ANALYSIS

Power Supply Model 4EP3A1 supplies the operating voltages for the station receiver. All connections to the receiver are made through plug and cable connections to the power supply chassis.

B-PLUS AND FILAMENT SUPPLY CIRCUITS

117 volts a-c is applied to the power transformer (T515) when the power switch (S502) is closed. The primary of the transformer is fused by F502, so that a short in the filament or B-plus supply will interrupt the input power. If a fuse larger than the 2-amp fuse specified is used, the equipment will not be adequately protected. The Receiver B+ supply is fused by F501, so that a short in the Receiver B+ will interrupt the power to the Receiver. If a fuse larger than the 1/8-amp fuse specified is used, the Receiver will not be adequately protected.

Low-voltage secondary winding G-G (green lead to green lead) provides 6.3 volts a-c for the receiver's filaments.

The voltage developed across the HV secondary winding transformer T515 is rectified by the full-wave bridge rectifier composed of CR517 thru CR524 to furnish B-plus voltage to the receiver. Filtering is provided by a capacity-input, LC filter composed of C519-A, B, C and D and L503. Metering resistors R513 and R514 are used when measuring the receiver B-plus voltage at jack J505. A 1-volt deflection on a 20,000 ohm-per-voltmeter at this jack indicates 100 volts of B-plus. R513 and R514 also serve as bleeders to discharge C519-A,B, C and D after the power supply is turned off.

AUDIO CIRCUITS

VOLUME control R526 and SQUELCH control R527 for the receiver are mounted on the power supply chassis. Muting the receiver during transmissions is accomplished by relay K509, which removes B-plus voltage from the receiver when energized by 6 volts d-c from the transmitter.

T503 is a line-matching transformer for matching the receiver output to a 600-ohm telephone line in remotely-controlled installations. The 100-ohm impedance between the RG and BL leads of the secondary (red and green lead to blue lead) is built out to 600 ohms by resistors R543 and R544. One watt delivered to the 3.5-ohm primary of T503 will apply +18 dbm to the telephone pair. This is the maximum allowable level on a phone line. For running long speaker lines or for other special applications, the full 600-ohm output may be obtained across the R-BL winding. Jacks J513 and J514 are provided for metering across the voice coil from the front of the power supply chassis.

30060

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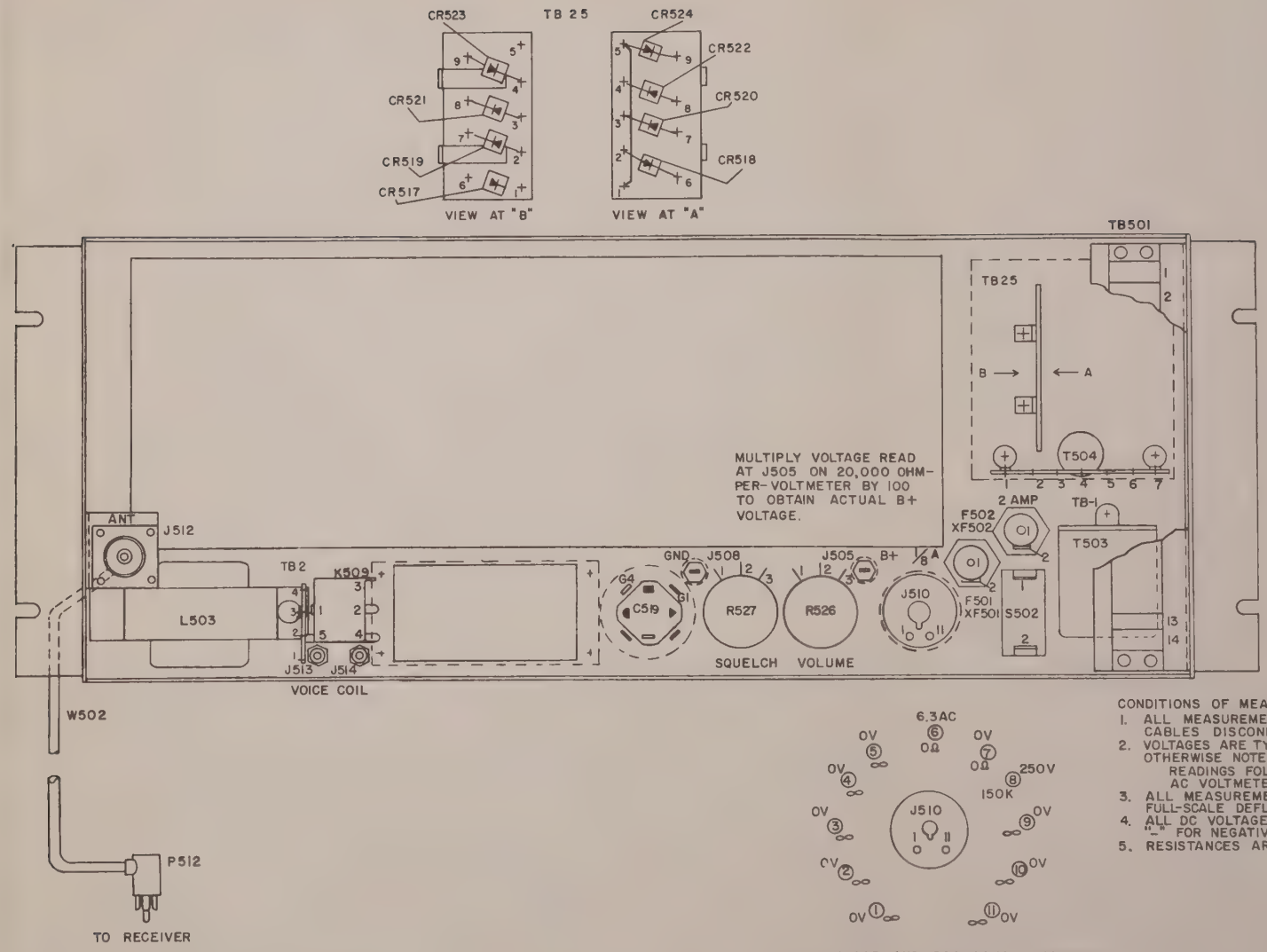


VOLTAGE AND RESISTANCE READINGS FROM TB501 TO GROUND

NO	VOLTAGE	RESISTANCE
1	(APPLY 117 VOLTS AC BETWEEN PINS 1 AND 2 OF TB501)	∞
2		∞
3	0	0
4	0	50
5	0	∞
6	0	∞
7	0	∞
8	0	∞
9	0	∞
10	0	∞
11	0	0
12	250	150K
13	0	∞
14	0	∞

VOLTAGE AND RESISTANCE READINGS FROM J510 TO GROUND

CONDITIONS OF MEASUREMENT:

1. ALL MEASUREMENTS MADE FROM INDICATED POINT TO CHASSIS WITH ALL CABLES DISCONNECTED FROM UNIT.
2. VOLTAGES ARE TYPICAL READINGS ON A 20,000 OHM-PER-VOLT DC METER, UNLESS OTHERWISE NOTED, WITH 117 VOLTS AC APPLIED BETWEEN PINS 1 & 2 OF TB501. READINGS FOLLOWED BY "AC" WERE OBTAINED WITH A 1000 OHM-PER-VOLT AC VOLTMETER.
3. ALL MEASUREMENTS MADE WITH A METER RANGE THAT GIVES ONE-THIRD TO FULL-SCALE DEFLECTION OF THE METER.
4. ALL DC VOLTAGES ARE POSITIVE WITH RESPECT TO CHASSIS, UNLESS MARKED "-" FOR NEGATIVE.
5. RESISTANCES ARE TYPICAL READINGS WITH ALL VOLTAGES REMOVED.

Service Outline

STATION RECEIVER POWER SUPPLY MODEL 4EP3A1

(D-7668899, Rev. 6)

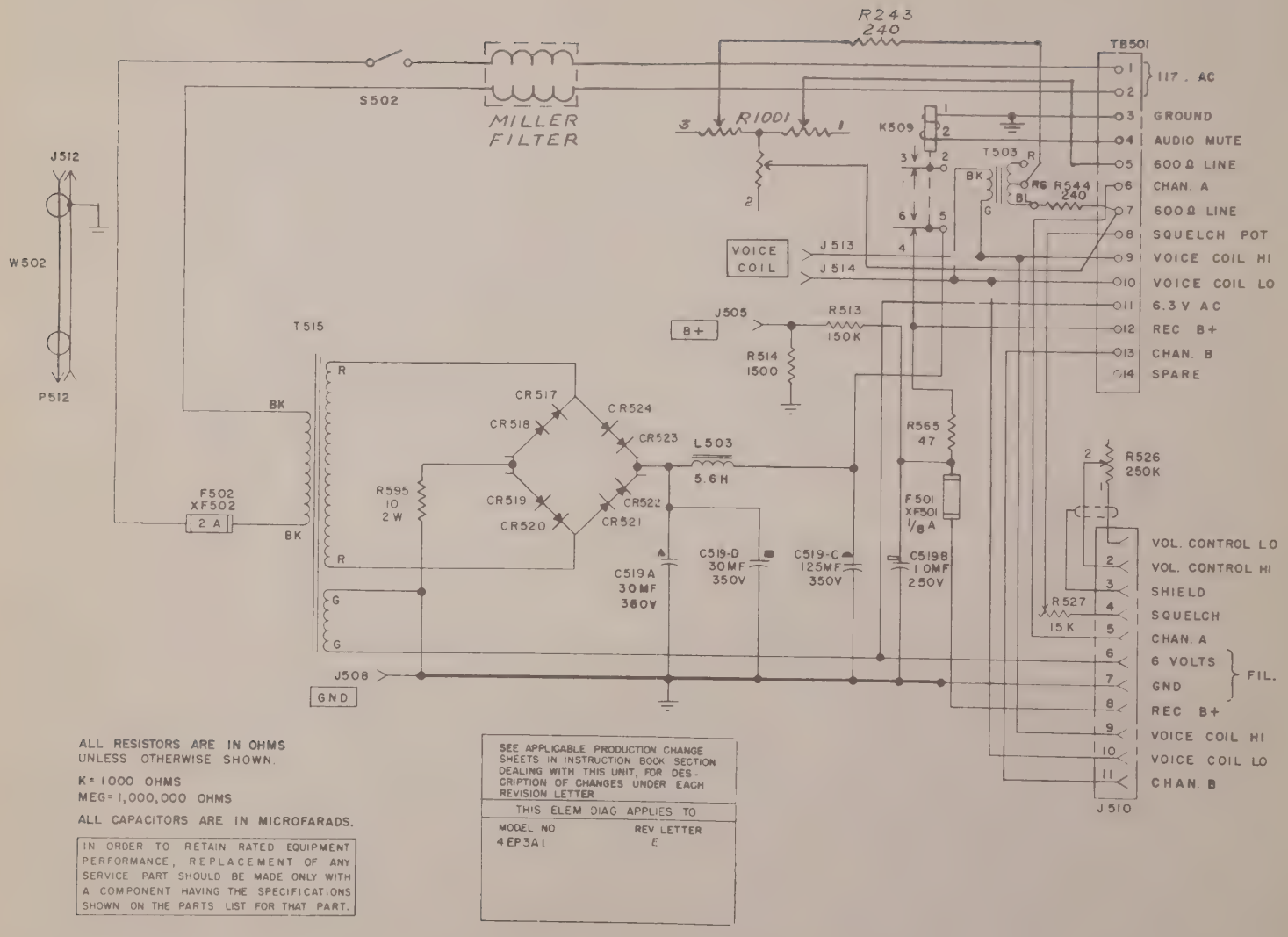
HINTS FOR SERVICING

The following list of service hints, in addition to the table of Typical Metering Voltages and the Voltage-Resistance Chart (see reverse side of page) will assist the serviceman in locating the source of trouble if the Power Supply should fail to operate properly.

SYMPTOM	SERVICE HINTS
Receiver completely dead.	Check line voltage (TB501-1,2).
	Check power fuse F502.
	Check output voltages at J510 with voltages listed on reverse side of page.
Receiver filaments lit, but no B+ at receiver.	Check readings at REC B+ jack (J505).
	L503 open.
Receiver will not mute on TRANSMIT.	Check operation on muting relay K501 on Power Supply. Check for presence of 6 volts between terminals 3 and 4 of TB501 on TRANSMIT.
B-plus voltage low.	Open rectifier.

TYPICAL METERING VOLTAGES

METER JACK		CIRCUIT	MULTIPLY METER READING BY	VOLTAGE
REC B+	J505	Receiver B-plus voltage	100	195 volts



ALL RESISTORS ARE IN OHMS
UNLESS OTHERWISE SHOWN.

K= 1000 OHMS
MEG= 1,000,000 OHMS

ALL CAPACITORS ARE IN MICROFARADS.

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER

THIS ELEM DIAG APPLIES TO	
MODEL NO	REV LETTER
4EP3A1	E

Elementary Diagram

STATION RECEIVER POWER
SUPPLY MODEL 4EP3A1, REV. E

(C-7775464, Rev. 14)
SPECIAL

EBI-41038J

PARTS LIST

STATION RECEIVER POWER SUPPLY

MODEL 4EP3A1, REV. E

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	CAPACITORS	
C502#	Deleted by Rev. A	
C519#	Electrolytic, polarized twist prong base. Similar to Mallory Type FP. Section A ▲: 30 mfd +100% -10%, 350 v d-c w; Section B ▭: 10 mfd +100% -10%, 250 v d-c w; Section C ◡: 125 mfd +100% -10%,350 v d-c w; Section D ■: 30 mfd +100% -10%, 350 v d-c w.	C-7770894-P48
	SELENIUM RECTIFIERS	
CR506# and CR507#	Selenium: forward current 50 ma. peak inverse 800 v per arm connected for doubler. G-E Cat. #6RS21PD13BBF1. Deleted by Rev. E.	A-7144141-P2
CR517# thru CR524#	Silicon rectifier, half wave; peak volts 400, capacitive load inverse 300, resistive load 500 ma. Similar to Westinghouse 1N1169. Added by Rev. E.	B-5490415-P2
	FUSES	
F501#	1/8 amp at 250 v, type 3AG, quick to medium blowing. Littelfuse Cat. #312.125. Bussman Cat. #AGC-1/8. Added by Rev. D.	K-1R16-P12
F502	2 amp at 250 v, Type 3AG, quick to medium blowing. Littelfuse Cat. #312002, Bussman Cat. #AGC-2.	K-1R16-P5
	JACKS AND RECEPTACLES	
J505	Test point jack, stake in, molded nylon. Alden Products Co. Type 110BC1-red.	A-7150763-P2
J508	Test point jack, stake in, molded nylon. Alden Products Co. Type 110BC1-black.	A-7150763-P1
J510	Connector, ring mount type; 11 female contacts, mica filled phenolic. Cinch Cat. #13786.	A-7140824-P2
J512	Receptacle. Amphenol Cat. #83-1R. Signal Corps #SO-239. Part of W502.	M-2R22-P3
J513 and J514	Test point jack, molded nylon. Alden Products Co. Type 110BCS1-light blue.	A-7143966-P6
	RELAYS	
K501#	Deleted by Rev. A.	
K508#	Added by Rev. A. Deleted by Rev. B.	
K509#	Miniature, resistance 19 ohms ± 10%, at 25°C, pick up 3 v d-c or less, operate 6.5 v d-c max, 2 form C, 3 amp at 115 v a-c non-inductive contacts. Price Electric Type #1051-16. Added by Rev. B.	B-7489216-P2
	INDUCTORS	
L503	Reactor: inductance 5.3 h min for an applied 60 cycle sine wave of 10 v RMS and 125 ma d-c resistance 210 ohms ± 20%.	A-7140333-P1
	Line Choke, Miller	D-7825-8
	PLUG	
P512	Part of W502	

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	RESISTORS	
R513	Composition, 0.15 megohm ± 5%, 1/2 w.	C-3R77-P154J
R514	Composition, 1500 ohms ± 5%, 1/2 w.	C-3R77-P152J
R526	Potentiometer, composition: 250,000 ohms ± 20%, 2 w, mod log taper. Allen Bradley Type J.	M-2R74-P62
R527	Potentiometer, composition: 15,000 ohms ± 20%, 2 w, linear taper. Allen Bradley Type J.	M-2R73-P55
R543 and R544	Composition, 240 ohms ± 5%, 1/2 w.	C-3R77-P241J
R565#	Composition, 47 ohms ± 10%, 1/2 w. Added by Rev. B.	C-3R77-P470K
R595#	Composition, 10 ohms ± 10%, 2 w. Added by Rev. E.	C-3R79-P100K
	SWITCH	
S502	Toggle type, midget, spst, 10 amp at 250 v, 15 amp at 115 v, 60 cycles. Hart Mfg. Co Cat. #164.	A-7144140-P1
	TRANSFORMERS	
T503	Audio. Pri imp: 3.5 ohms, sec imp: 100/600 ohms ± 10%.	B-7487236-P1
T504#	Deleted by Rev. D.	
T515#	Filament and rectifier, single phase. Pri: 117 v ± 10%, 50/60 cycles; sec #1: 186 v, 0.215 amp; sec #2: 6.0 v, 8.0 amp. Added by Rev. D.	B-5490235-P1
	CABLE	
W502	Includes One cable and plug assembly. One hood Type UG-177/U. One Amphenol receptacle, Cat. #83-1R.	A-7146725-G3 B-7488600-P91 K-7114629-P1 M-2R22-P3
	SOCKETS	
XF501# and XF502	Fuse holder. Bussman Type HKP. (XF501) Added by Rev. D.	K-7115179-P1
	ATTENUATOR	
R1001	T-Pad, wirewound, 4W; 600 ohm impedance ± 15% between 5% and 95% rotation. Similar to Mallory Type T600	P-7772843-P18

INSTALLATION AND OPERATION OF THE CARRIER-OPERATED RELAY PL-7486775-G2 FOR STATION RECEIVERS TYPES ER-7-A, ER-7-B, ER-8-A, ER-9-A, ER-21-A, ER-22-A AND PROGRESS LINE RECEIVERS

The carrier-operated relay is an accessory which may be installed on a station receiver to open or close an external circuit whenever a carrier is received.

The carrier-operated relay assembly consists of a d-c amplifier and relay tube to operate the functional relay. The controlling voltage is obtained from the squelch circuit of the receiver. A "Threshold" control is provided to synchronize the opening and closing of the relay with the opening and closing of the receiver squelch.

INSTALLATION:

The carrier-operated relay is designed for mounting to the receiver or receiver Power Supply of 450 MC and Progress Line Stations, by removing the small plate attached to the accessory cut-out of the chassis.

Preliminary Modification of the Station Receiver Type ER-7-A, ER-7-B or ER-8-A

When installing Carrier Switch PL-7486775-G2 in Receiver ER-7-A, ER-7-B, or ER-8-A the following preliminary modifications should be made.

NOTE

R407 (Shown in phantom on respective Receiver Elementary Diagrams) is not required for application of this kit.

1. Clip our resistor R354 (8.2-megohm resistor soldered from XV310-1 to two point terminal board), capacitor C392 (0.01-mfd capacitor soldered from XV310-1 to ground) and capacitor C393 (0.01 mfd capacitor soldered across two point terminal board.

2. Solder a wire, of ample length, from XV310-2 to TB301-13.

Preliminary Modifications of the Receiver Type ER-9-A

1. Clip out resistor R382 (8.2-megohm resistor connected from XV313-1 to TB4-4).

2. Solder a wire, of ample length, from XV313-2 to TB301-13.

General Procedure for Installing Carrier-Operated Relay PL-7486775-G2 in Receiver Types ER-7-A, ER-7-B, ER-8-A, ER-9-A, ER-21-A, ER-22-A and Progress Line Receivers.

1. Mount the carrier controlled switch in the cut-out provided by the removal of the accessory cover plate.

2. Connect the red wire of the switch to terminal 12 of the receiver (Receiver Power Supply for 450 MC or Progress Line equipment) main terminal board.

3. Connect the green wire of the switch to terminal 13 of TB301 (ER-7,8,9 and 21). In 450 MC or Progress Line Receivers, solder this wire with the in-line connector directly to the Squelch Amp. grid (XV316-7 in 450 MC receiver or XV312-2 in Progress Line Receiver). Use wire-wrapped terminal number 15 on printed board for 450 MC Progress Receivers. XV316-2 squelch grid is brought out to this stake.

4. Connect the brown wire of the switch to terminal 11 of the receiver (Receiver Power Supply for 450 MC or Progress Line Equipment) main terminal board.

APPLICATION REQUIREMENTS:

If Carrier Operated Relay PL-7486775-G2 is used in repeater applications, the relaying receiver must be connected so that the associated transmitter does not mute it. This is done in Progress Line equipment by removing the harness wire, terminated at terminal 4 on the Receiver Power Supply Barrier Board. For Receivers prior to Progress Line, add a jumper between terminal 3 and terminal 4 on the Receiver main terminal board.

When using Carrier Operated Relay PL-7486775-G2 with:

a) The Cathode Follower Kit PL-7144882-G1, connect

COR Terminal	To Control Panel
K662-1 (Microswitch normally closed)	KC-4-B or KC-10-A terminal TB702-4
K662-2 (Microswitch common)	KC-4-B or KC-10-A terminal TB703-1

b) The Transmitter 5 Second Drop Out Delay Kit PL-7144901-G1, connect

COR Terminal	To Control Panel
K662-1 (Microswitch normally closed)	KC-4-B or KC-10-A terminal TB702-4
K662-2 (Microswitch common)	KC-4-B or KC-10-A terminal TB703-1
K662-3 (Microswitch normally open)	KC-4-B or KC-10-A terminal TB703-6

c) The Transmitter 3 Minute ON Limit Timer Kit PL-7144902-G1, connect

COR Terminal	To Control Panel
TB2-2	KC-4-B Terminal TB704-3 or KC-10-A Terminal TB703-1
TB2-3	KC-4-B Terminal TB703-10 or KC-10-A Terminal TB703-9

In Progress Line Stations the above wires are a part of the Repeater Control Overlay harness PL-7147091-G1. When making modification in the field, refer to the Repeater Control Overlay Harness Interconnection Diagram for harness wire numbers to be used for the application. This drawing may be found in the Installation Section of the Station Combination Instruction Book.

ADJUSTMENT AND OPERATION:

With the station system in complete operation, the "Threshold" control of the carrier-controlled switch should be adjusted as follows:

1. Adjust the receiver squelch control to critical squelch; i.e., until the noise in the speaker is just silenced.

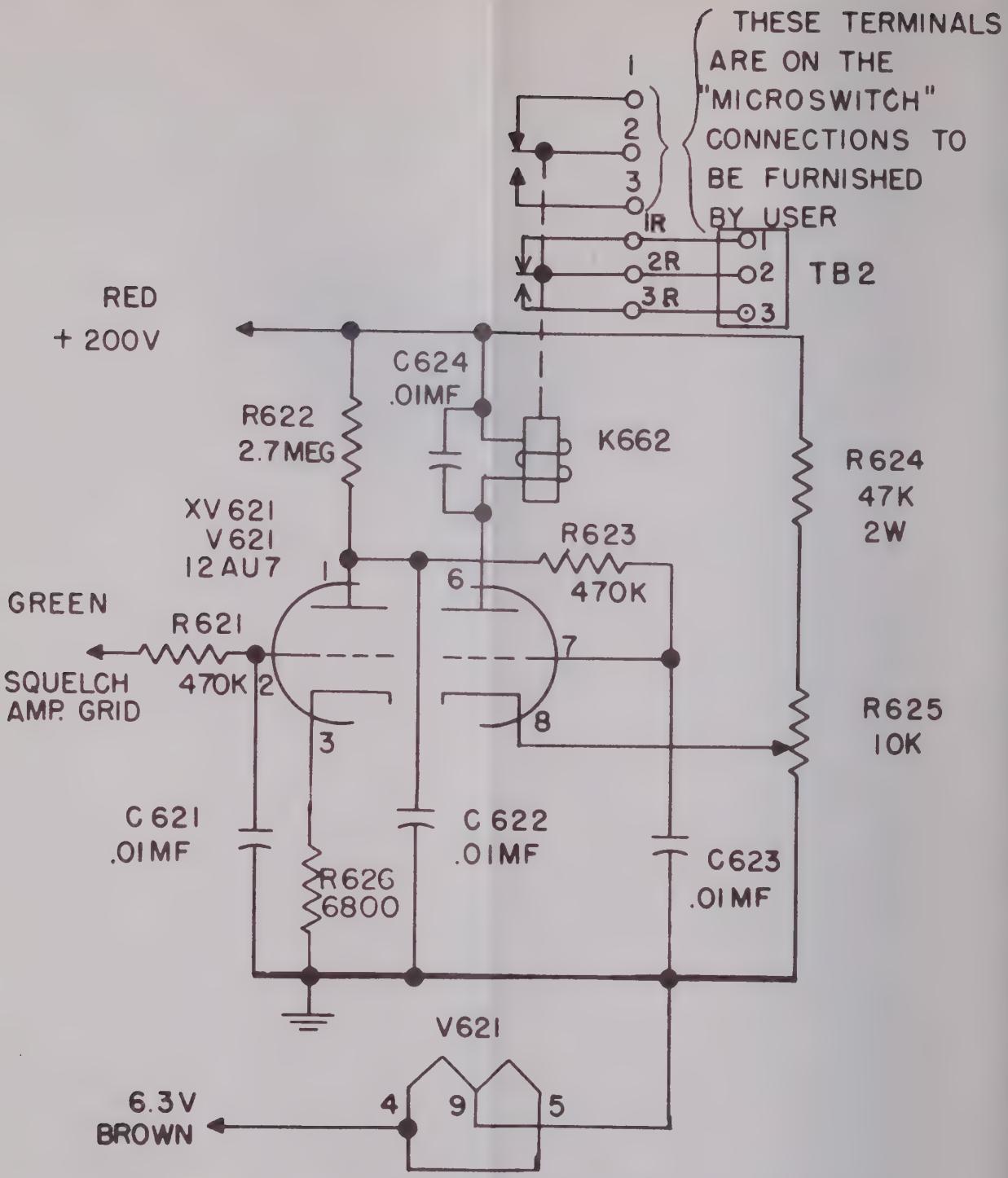
2. Turn the "Threshold" control of the carrier operated relay until the relay picks up (energizes).

3. Turn the "Threshold" control in the opposite direction until the relay just drops out. Do not turn

Symbol	Description	G-E Drawing
	SOCKET	
XV621	Tube socket: mica filled phenolic, 9 pin miniature, 4 ground ears.	M-7480532-P8

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

Printed in U.S.A.



RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS, OR MEG=1,000,000 OHMS.

Elementary Diagram

CARRIER OPERATED RELAY
PL-7486775-G2

(A-7142548, Rev. 0)

INSTRUCTIONS FOR LOCAL CONTROL PANEL 4KC4B2 SPECIAL

General Electric Control Panel Model 4KC4B2 for this requisition designed to be utilized as a local control point for Fixed Service ote Control Installations, or for control of Relay Stations without e. The basic panel has been modified by the application of Standard ions and special circuits, to provide for operation in accordance h specifications set forth by the customer.

Input power and audio specifications for the Panel are listed in table which appears below, and the description, adjustment and operon of the various components is outlined in the following pages.

The Panel is wired in accordance with Elementary Diagram D5498728, the Parts List (LBI-8069) is printed on the reverse side.

SPECIFICATIONS

nput Voltage	117 volts a-c ± 10%, 60 cps.
emperature Range	-30°C to +60°C (-22°F to +140°F)
modified by Cathode Follower:	
Nominal Frequency Range	300 to 3000 cps
Frequency Response	Receiver response corrected to be ± 3 db from 1000 cps reference, from 300 to 3000 cps (when using transmitter as signal source).
ated Output	0.1 volts
armonic Distortion @ .25 volts output at 1 kc	Load: 300 ohms — Harmonic Distortion: 1.5 % Load: 600 ohms — Harmonic Distortion: 1.0 % Load: 900 ohms — Harmonic Distortion: 0.8 %
oltage Gain @ 1000 cps with 600 ohm load	0.1/0.56 = 0.178
nput Impedance	1.2 megohms
utput Impedance	400 ohms
orks into loads from 200 to 1000 ohms.	

DESCRIPTION

The local control panel serves as a termination point for system nections and contains the Master Power Switch (S702), for supplying er to units in the Combination. One section of the switch opens or ses the high side of the unregulated 117 volt a-c power circuit, and second section opens or closes the high side of the regulated a-c. ipment operating from either section is protected by a 20 ampere e. A convenience outlet is connected across the unregulated input rcuit.

The 1-Minute Filament Delay Relay (Z704) prevents high voltage m being applied to the transmitter until the filaments have warmed , thus minimizing maintenance and prolonging vacuum tube life.

The Transmitter 5-Minute On Limit Relay (Z703) has been designed automatically terminate transmissions in excess of five minutes. en the transmitter is keyed from the Remote Control Unit, or upon osure of the Carrier Operated Relay, the clocktimer in Z703 is start- . At the end of five minutes, the ground return side of the keying lay circuit is opened and the timer circuit broken. Reset of the ti- r is automatic.

In repeater service application, the Control Panel employs the thode Follower Kit (Z701) to match receiver output to the transmitter put. The receiver signal is obtained after the discriminator and is d to the grid of the audio amplifier through a response tailoring net- rk (Tone Compensating Network, PL-7150715-G6). The network compen- tes the receiver output such that the resultant response (Mobile ansmitter to Relay Receiver to Relay Transmitter) is within 3 db of a 00 cps reference from 300 to 3000 cycles. The output of the audio plifier is fed to the grid of the Cathode Follower thru a transmitter put level potentiometer (R6), which controls the modulation level in- pendently of the receiver volume control. The transmitter modulation put signal from the Cathode Follower is terminated at TB702-2 .

Transmitter Drop Out Delay Kit (Z702) is designed to hold-in the lay Transmitter keying circuit for 5 seconds after release of the rrier Operated Relay, to minimize undue cycling and surging of the lay Transmitter. A 50 MF capacitor across the field winding of the lay is charged whenever the transmitter keying circuit is energized; ien the keying circuit is opened, approximately 5 seconds elapse be- ore the charge on the capacitor leaks off, permitting the relay to pen. Increasing the size of Capacitor C1 will effect increased Delay ime, if required.

ADJUSTMENT

The adjustment outlined below is required only when the Station s to be used in Relay Service.

After the modulation setting of the transmitters has been check- d or adjust the TRANS INPUT LEVEL control (R6) on the Cath- de Follower

While receiving a signal which is modulated by a loud, clear
e (such as a loud whistle), adjust the TRANS INPUT LEVEL for one
the following readings:

1. 0.1 volt on an RMS Vacuum Tube Voltmeter, connected between terminals 1 and 2 of TB702 on the Control Panel.

2. A frequency deviation of 10 kilocycles (wideband systems) or 4 kilocycles (narrow-band systems) on an FM receiver which is monitoring the Relay Transmitter.

OPERATION

ıed Service Remote Control

When the 4KC4B2 Panel is used in Fixed Service Remote Control
ıstallations, switches on the Panel must be set in the following
ısitions:

S702	OFF	(unless continuous application of primary power is desired)
S703	DISABLE	(Repeater not being used)
S704	REMOTE	

With Panel switches set as indicated, the sequence of operaon will be as follows:

1. Input power is turned ON at the Remote Control Unit and energizes a control relay in the 4KC7B2 Remote Control Panel
2. The 4KC7B2 Control relay completes an a-c circuit to the power relay (K701) on the 4KC4B2 Panel.
3. K701 energizes and primary power is applied to the filaments and to the 1-Minute Timer Circuit (Z704).
4. After approximately one minute, Z704 closes and returns the transmit ground circuit to the 4KC7B2 Panel, where it will be controlled by the Remote Control Unit. (See step 6 below).
5. When the transmitter is keyed, a-c power is supplied to the Transmitter 5-Minute On Limit (Z703), which operates as described on page 2 of this instruction.
6. Remote selection of the individual channels can be made only when S704 (4KC4B2 Panel) is in the REMOTE position; this places the channel selector relays (4KC7B2 Panel) under control of the Channel Selector Switch on the Remote Control Unit (EC28A).

NOTE: When the switches on the 4KC4B2 Panel are set for Fixed Service Remote Control operation, switches on the 4KC7B2 Panel must be set as follows:

Receiver OPERATE - MUTE	MUTE position
REMOTE OPERATE -DISABLE	REMOTE position

ay Service

If the Combination is to be used as a repeater station in Relay plications, first determine the frequencies on which the transmit- and receiver will be operating. Appropriate channel spacing is quired. The transmitter and receiver frequencies furnished in this quisition are listed in Figure 2.

1. After the proper transmitter and receiver frequencies have been installed (in channel 2, for example), set the switches on the 4KC4B2 Panel, as follows:

   S702 ON

   S703 OPERATE

   S704 CHANNEL 2

   NOTE: Switches on the 4KC7B2 Remote Control Panel must be set to the following positions:

   Receiver OPERATE - MUTE OPERATE position
   REMOTE OPERATE - DISABLE DISABLE position

2. Adjust the Carrier Operated Relay (on the 4EP3A1 Power Supply) in accordance with instructions contained in EBI-4977.

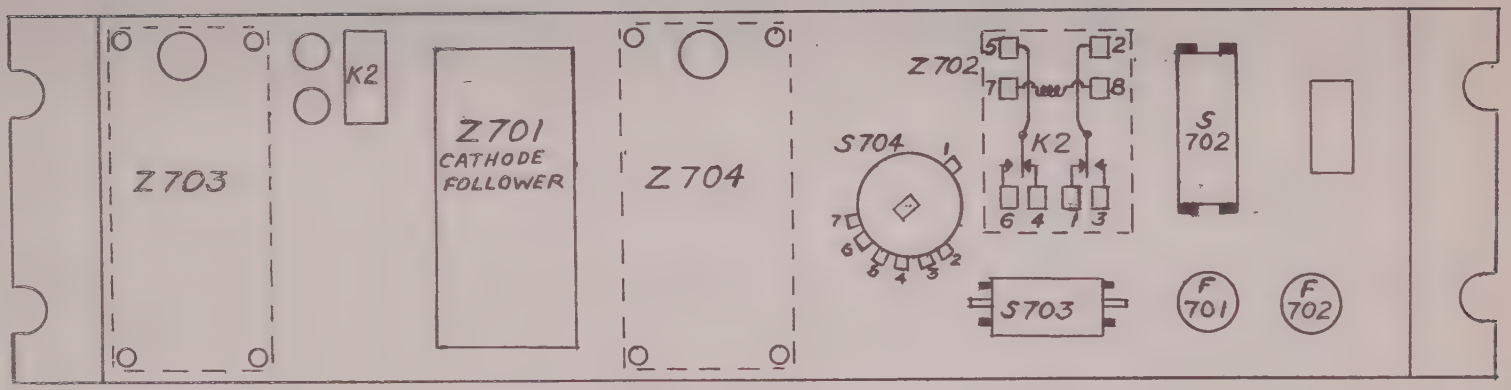
3. Check the Relay Station for the following sequence of operations:

   a. Carrier is received:

      (1) Carrier Operated Relay picks-up.
      (2) Relay K1 (part of Z702) is energized, keying transmitter; capacitor C1 charges.
      (3) 5-Minute Timer starts.

   b. Carrier drops out:

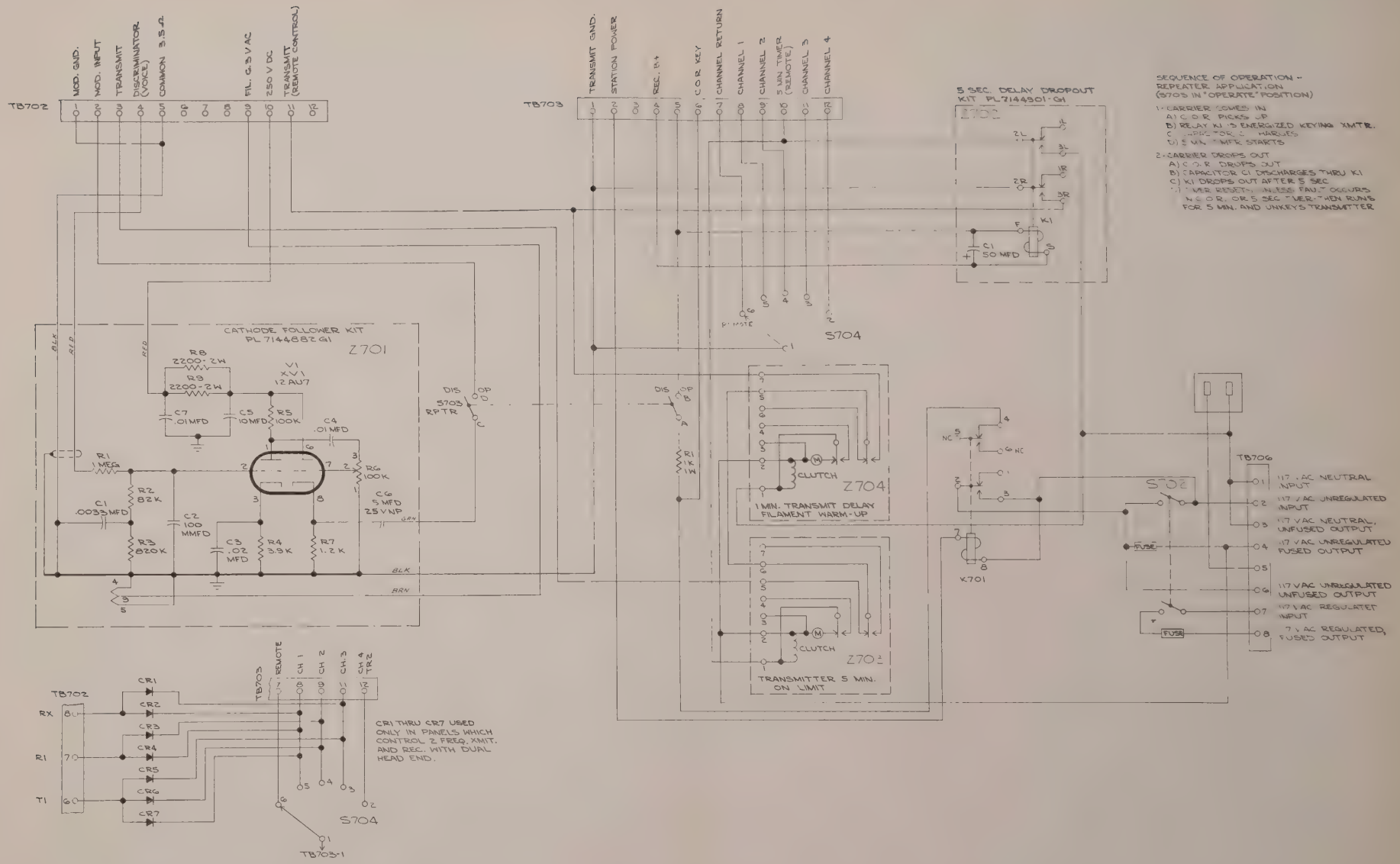
      (1) Carrier Operated Relay drops out.
      (2) Capacitor C1 discharges thru K1, and K1 drops out after 5 seconds.
      (3) The 5-Minute Timer automatically resets (unless fault occurs in the C.O.R or 5-Second Drop Out Delay, in which case the timer will run for 5 minutes then un-key the transmitter).



REAR VIEW

4KC4B2 LOCAL CONTROL PANEL
(SPECIAL)

FIGURE 1



Elementary Diagram

LOCAL CONTROL PANEL
4KC4B2 SPECIAL

(D-5498728, Rev. 0)

PARTS LIST

LOCAL CONTROL PANEL
MODEL 4KC4B2
(SPECIAL)

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	RECTIFIERS	
CR1 thru CR7	Silicon, insulated, 500 ma at 25°C, 250 ma at 100°C; peak volts 400, rms 280; peak surge current, recurrent 60 cycle, 2.5 amp. One cycle surge 15.0 amps. Color, Yellow.	B-5492294-P4
	FUSES	
F701 and F702	Cartridge type, quick to medium blowing; 20 amps at 250 V, type 3AG. Littelfuse Cat. No. 314020. Bussman Cat. No ABC-20.	M-7484390-P5
	JACKS AND RECEPTACLES	
J702	Connector receptacle; 10 amps at 250 V, 15 amps at 125 V. Cinch Cat. No 54A12844.	A-7128081-P1
	RELAYS	
K701	Resistance 445 ohms ± 10%, min operating 95 V, 60 cycle, operating voltage range 115 V ± 10%, 60 cycle; 2 Form C contacts; contact pressure 30 gms minimum.	B-7489014-P1
	RESISTORS	
R1	Composition, 1000 ohms ± 10%, 1 watt	C-3R78-P102K
	SWITCH	
S702	Toggle type; dpst, 6 amps at 250 V, 12 amp at 125 V. Arrow-Hart and Hegeman Cat No 82143, except with bat handle.	K-7109677-P1
S703	Toggle type; dpst, 6 amps at 250 V, 12 amps at 125 V. Arrow-Hart and Hegeman Type 20902-BJC	M-7478623-P2
S704	Rotary; dpst, adjustable, max. 5-position; ceramic, non-shorting contacts.	P-7769759-P1
	TERMINAL BOARD	
TB702 and TB703	12-terminals supplied with Y terminals and terminal screws, but without marker strips. HB Jones Cat. No 12-164-Y	C-7774187-P207
TB706	8-Terminals, supplied with Y terminals and terminal screws, but without marker strip. HB Jones Cat. No. 8-164-Y	C-7774187-P205
	SUB-ASSEMBLIES	
	KITS	
Z701	Repeater Station Cathode Follower Kit (contains the following parts):	PL-7144882-G1
	CAPACITORS	
C1	Paper, molded plastic, 0.0033 mf ± 20%, 400 VDCW. Sprague Cat. No. 109P33204.	B-7491096-P24
C2	Silver Mica, CM15 case; 100 mmf ± 5%, 500 VDCW. Electro Motive Mfg. Type CM15	P-3R122-P47
C3	Ceramic, hi-K disk; 0.02 mf +100% -0%, 500 VDCW	C-7774750-P15
C4	Paper, molded plastic, 0.01 mf. ± 20%, 400 VDCW. Sprague Cat. No. 109P10304.	B-7491096-P27
C5	Electrolytic: tubular, 10 mfd +50% -10%, 450 VDCW. PR Mallory Cat No. TC-72	C-7774786-P41
C6	Dry electrolytic, tubular, non-polarized, 5 mf +100% -10%, 25 VDCW, without mounting strap.	B-7488462-P1
C7	Ceramic, Hi-K disk, 0.01 mf +100% -0%, 500 VDCW.	C-7774750-P13
	RESISTORS	
R1	Composition, 1.0 megohm ± 10%, 1/2 w.	C-3R77-P105K
R2	Composition, 68,000 ohms ± 10%, 1/2 w.	C-3R77-P683K
R3	Composition, 0.82 megohm ± 10%, 1/2 w.	C-3R77-P824K
R4	Composition, 3900 ohms ± 10%, 1/2 w.	C-3R77-P392K
R5	Composition, 0.10 megohm ± 10%, 1/2 w.	C-3R77-P104K
R6	Potentiometer, carbon film, 100,000 ohms ± 20% mod log taper, 0.10 w. With split bushing and locking nut. Chicago Telephone and Supply Type No. 70.	B-7487391-P102
R7	Composition, 1200 ohms ± 10%, 1/2 w.	C-3R77-P122K
R8 and R9	Composition, 2200 ohms ± 10%, 2 w.	C-3R79-P222K
	TUBE	
V1	Type 12AU7	
	SOCKET	
XV1	Tube Socket; 9-pin miniature, mica-filled phenolic, 4 ground ears.	M-7480532-P8
	CABLE	
	22-inch, two-conductor shielded cable	A-7145237-G1
Z702	Drop Out Relay Kit (contains the following parts):	PL-7144901-G1
C1	Capacitor: electrolytic, insulating sleeve, polarized twist prong base, 50 mf + 50% - 10%, 350 VDCS, Mallory Type FP.	P-7772471-P31
K1	Relay: pickup 3.5 ma or less, resistance 21,000 ohms ± 10%, twin 2 form C contact with magnetic shielding cover and cover guide. CP Clare Type J.	P-7773439-P32
Z703	Relay: motor driven time delay, 115 v ± 10%, 60 cycle coil, 5 min ± 10% time delay at 60 cycles, dpdt contacts.	B-7486817-P1
Z704	Relay: motor driven time delay, 115 v ± 10%, 60 cycle coil, 1 min ± 10% time delay at 60 cycles, dpdt contacts.	B-7486817-P4

EBI-41061
Special

INSTRUCTIONS FOR REMOTE CONTROL PANEL

MODEL 4KC7B2

General Electric Remote Control Panel, Model 4KC7B2 (Special) as been designed as a companion to Remote Control Combination RC 4 EC28A Control Unit, Special). The Panel responds to channel con-rol voltages received via telephone lines from the Remote Control nit, and selects associated transmit-receive channels installed in he Station Combination.

Circuitry for the Remote Control Panel is shown on Elementary iagram D5498766 , and the Parts List (EBI-41596) is printed on he reverse side. The Panel must be connected to the Remote Con-rol Unit, in accordance with Figure 1.

SPECIFICATIONS

Dimensions	19" x 3-1/2" x 8" (4-3/8" in front of mounting surface and 3-1/8" in back of mounting surface.
Weight	8 lbs. (panel less options)
Input Voltage Requirement	117 volts a-c ±10%, 60 cycles
Temperature Range	-30°C to 60°C (-22°F to 140°F)
Nominal Frequency Range	200 to 5000 cps
Input Characteristics for signals from telephone line to transmitter:	
Input Impedance from line to panel	- 600 ohms ±10%
Output Impedance from panel to transmitter	- 600 ohms ±10%
Insertion Loss	- 3 db
Minimum Signal for 70% Modulation	- -16 dbm
Input Characteristics for signals from receiver(s) to telephone line:	
Input Impedance from receiver to panel	- 600 ohms ±10%
Output Impedance from panel to line	- 600 ohms ±10%
Insertion Loss	- 3 db

INSTALLATION

The Remote Control Panel is assembled and mounted to the standard RETMA rack of the Station Combination. System interconnections are made through a wiring harness as shown on Interconnection Diagram , located in the Installation Section of the Combination Instruction Book.

The key link in any remote control installation is the telephone pair from the Remote Control Unit to the Remote Control Panel. In order to obtain the most satisfactory service over this link, some general knowledge of line capabilities and control methods is essential. A brief description follows:

TELEPHONE LINE CHARACTERISTICS

A telephone pair is simply a pair of wires, ranging normally from wire-size AWG #19 to AWG #26. As installed by the local telephone company, the wires may pass through overhead cables, underground cables, junction points and switchboards. The usual telephone line is constructed to have a characteristic impedance of 600 ohms (stated normally at a frequency of 1000 cycles), and any equipment designed to operate into (or from) such a pair, should have a nominal output/input impedance of 600 ohms.

Normally, any single telephone pair will run a maximum length of 12 miles before amplification is added by the telephone company to make up for line losses. There is an inherent loss in any telephone line installation, due to series inductance, resistance and shunt capacitance of the wires. This loss is a direct function of the length of the line, and varies with the size wire used. As an example, with wire size AWG #19, a distance of six miles may be covered before one-half the input voltage of 1000 cps tone has been lost. With wire size AWG #26, only two and one-quarter miles may be covered before one-half the input voltage is lost. Line losses (as high as 10:1) can be tolerated in operating a transmitter from the EC28A remote control unit, but should be avoided if possible. Although the telephone pair is fairly well shielded, there will be some noise pick-up, especially if an unshielded run is made through a flourescent-lighted building to the control unit or transmitter.

The amount of noise picked up in any one location is a function of the length of line and the environment through which it passes. Assume, for instance, that 0.01 volts of output of the remote control unit is 1 volt and the line loss is 10:1, the audio signal at the base station is 0.1 volt, only 10 times (20 db) higher than the noise. This relatively high background noise would greatly reduce the intelligibility of the system and, consequently, the maximum working range. Now, let us consider a short line on which the noise pick-up is only 0.002 volt and the line loss only 2:1. Then the signal at the receiving end would be 250 times (48 db) greater than the noise. For best signal-to-noise ratio, the shortest, lowest loss line available is desired.

Another inherent characteristic of any telephone line is that the line loss is greatest at the highest audio frequencies. Assuming that the range of voice frequencies is approximately 400 to 3500 cps, then the loss at 3500 cps will be about 2-1/2 times that at 400 cps. This means that, in the case of a long telephone line where the total loss is high, the high frequencies will be attenuated considerably, rendering a bassy quality to the transmissions. In the case of a short line, where the total loss is low, the difference between the high and low frequencies will not be great enough to be audible. If, on a particular installation, the resulting quality is too bassy for good intelligibility, steps can be taken to improve the quality.

There is, of course, a d-c resistance in any telephone pair. This resistance plays an important part in the control circuits and will affect the relay currents obtained. The equipment will operate with a total control line loop resistance of 800 ohms (when the panel is modified with additional relay(s) for more control functions). If the telephone company cannot supply lines with less than 800 ohms loop resistance on a particular application, then a slight change can be made. (See the Section on Modifications).

Standards have been set up by the telephone companies on the use of their lines. In order to minimize cross modulation (i.e., audio being picked up by one pair of wires from another pair), a limit of ≠8 vu has been set as the maximum level of voice signal that can be placed on the telephone line. Vu is the abbreviation for volume units, as read on a vu meter connected across a 600-ohm line.

Since vu meters are not common in the field, a second standard for maximum telephone line signals is often used. It has been found that speech at a voice level of ≠8 vu contains peak values which correspond to the peak value of a sine wave at a signal level of ≠18 dbm on a 600-ohm line. ≠18 dbm is equal to 18 db above 1 milliwatt or 6.2 volts across 600 ohms. In this equipment, the peaks which represent the maximum signal of 100% modulation will be equivalent to the peaks of a sine-wave signal at the ≠18 dbm level. In adjusting the system, a tone of no more than ≠18 dbm may be used in establishing the 100% modulation point.

Limits also exist on the maximum d-c voltages that may be applied across the telephone lines. These are 270 volts from line to line and 135 volts from either line to ground. The maximum current obtainable under short circuit conditions in the line must be less than one ampere. Both limits must be met, even when the telephone line is open or short-circuited. Remote Control Unit Model 4EC28A1 has been designed to meet these telephone company specifications.

CONTROL CONNECTIONS

For d-c control voltage circuits, the telephone company can supply a pair of wires that will definitely have d-c continuity. This line is commonly called a metallic pair. Telephone lines used for audio work are not necessarily of this type; therefore, it is necessary to specify that a metallic pair be used.

ADJUSTMENT

The TRANS INPUT LEVEL adjustment (R709) on the remote control panel should be adjusted as follows: (Before making the adjustment below, the transmitter modulation control and the remote control unit adjustments should have been made, following the method prescribed in their respective Instruction Books).

1. Feed a 1000-cps tone into the microphone input of the Control Unit; press the TRANSMIT key on the Control Unit and adjust the 1000-cps source (without changing any EC-28-A adjustments) to obtain a +18 dbm output from the EC-28-A. Then adjust the TRANS INPUT LEVEL (R709) on the Remote Control Panel until the swing is ±11 kilocycles, as indicated on a suitable monitor. (If narrowband equipment is being modulated, set R709 for ±4.0 kilocycles.)

2. If a frequency modulation monitor is not available, the correct setting of the remote level adjustment may be determined by applying the tone at the remote control unit as described above, and adjusting the TRANS INPUT LEVEL on the remote control panel for an RMS reading of approximately 0.1 volt across terminals 1 and 2 of terminal board TB702 on the remote control panel.

3. If a 1000-cycle tone is not readily available for step 2 above, R709 may be set approximately by speech-modulating the transmitter from the remote point and then setting the TRANS INPUT LEVEL adjustment at the station, so that the peak swing never exceeds ±15 kc (±5 kc for narrowband equipment). Of course, in order to perform this step, the controls within the remote control unit used should first be adjusted, following the methods outlined in the Remote Control Unit Instruction Book.

MODIFICATIONS

In some installations, the Remote Control Unit may be operating under adverse conditions (with reference to the length of telephone lines). When this is the case, some modifications can be made to utilize the remote dispatching unit to its fullest capabilities, as indicated in the paragraphs below:

1. Very Long Lines

When operating with very long lines, there are three problems that arise:

A. Poor signal-to-noise ratio.

B. Bassy quality of signals heard.

C. Improper operation of relay control circuits.

Problem A above can occur not only when the lines are long, but also when they are located in a particularly noisy area. The noise on a telephone line increases with its length. As the noise voltage at the receiving end of a telephone pair is relatively constant, the obvious method of obtaining a better signal-to-noise ratio is to increase the signal voltage. Unfortunately, this cannot be done on most telephone lines, as the maximum voltage is set by the Telephone Company. Where the lines are privately owned, however, higher signals may be permitted and can be of advantage in improving the signal-to-noise ratio.

The signal placed on the line by the receivers can be increased by two methods: by advancing the VOLUME control on the receiver chassis, or by connecting a jumper across the impedance-matching resistors in series with the 20-ohm output winding of the output transformer on the receiver. By-passing the resistors will increase the output of the line by about 6 db, but will also lower the impedance of the KC-7-B seen by the line during "listening". This will be of little consequence, as a small loss in speaker volume can be tolerated.

Problem B is due to the shunt capacitance of long lines, which attenuates the higher frequencies. The high-frequency response of the Remote Control Unit can be increased according to the individual instruction books. The telephone line can be compensated to attenuate the low frequencies by replacing C702 (4 mfd) by a 0.5-mfd capacitor for line-to-line operation. The telephone line does, however, become unbalanced at low frequencies when remote squelch is used.

Problem C occurs when the total d-c resistances of the telephone line loop exceed 2500 ohms. Resistances of this order are not normally encountered, except in installations where very long telephone lines are used.

When this is the case, the Channel-Three relay on the remote control panel may fail to pick up when the 105-volt control voltage is applied at the remote end. This can be corrected by shorting out R707 on the remote control panel. (Operating with the d-c control voltage simplexed line to ground essentially halves the d-c resistance, meaning that longer lines may be used with this method than the other two).

OPERATION

The Remote Control Panel serves as an accessory to the Base Station and is controlled from the remote point. As such, the operation is automatic.

When the Base Station is remotely controlled by the RC 4 Combination, the ON-OFF switch (on the 4KC7B2 Panel) can remain in the OFF position; however, the switch must be placed in the ON position if the Station is used in repeater/relay service.

MAINTENANCE

The collection of dust on relay contacts may result in intermittent operation. This dust problem has been greatly decreased by the use of relay dust covers, but if it should occur, the relays should be blown out with compressed air. Should an oily film form on the contacts, it may be removed by cleaning with a burnishing tool. Care should be taken not to bend the springs. The residual screw and armature adjustments have been set at the factory to operate the relays on a certain range of currents. Do not tamper with these adjustments.

WARNING: DANGEROUS HIGH VOLTAGES will be present in the Base Station when the Combination is keyed by the Remote Control Unit, even though the power switch on the 4KC7B2 panel is in the OFF position.

During maintenance periods, disable the Remote Control Unit by placing the REMOTE-OPERATE DISABLE switch in the DISABLE position, and place the power switch in the OFF position.

CIRCUIT DESCRIPTION

For analysis of the Remote Control Panel circuits, refer to Elementary Diagram.

AUDIO CIRCUITS

Control signals for remote operation travel over a telephone line audio pair, which is terminated at the primary winding of the line matching transformer on the Remote Control Panel (TB701-1 and 2).

The Remote Control function and the path of audio signal is dependent upon the operation of selection relay, K701. When relay K701 is de-energized, the secondary winding of the line-matching transformer is connected to the Station Receiver(s) through contacts 1R and 2R, thus feeding the Station Receiver(s) output to the telephone line audio pair. Energizing relay K701 transfers the secondary winding to the transmitter modulation input circuit through a 600-ohm T-pad. This circuit is completed through contacts K701-2R and 3R. The T-Pad provides control over the transmitter input level, while maintaining a constant impedance load on the telephone pair.

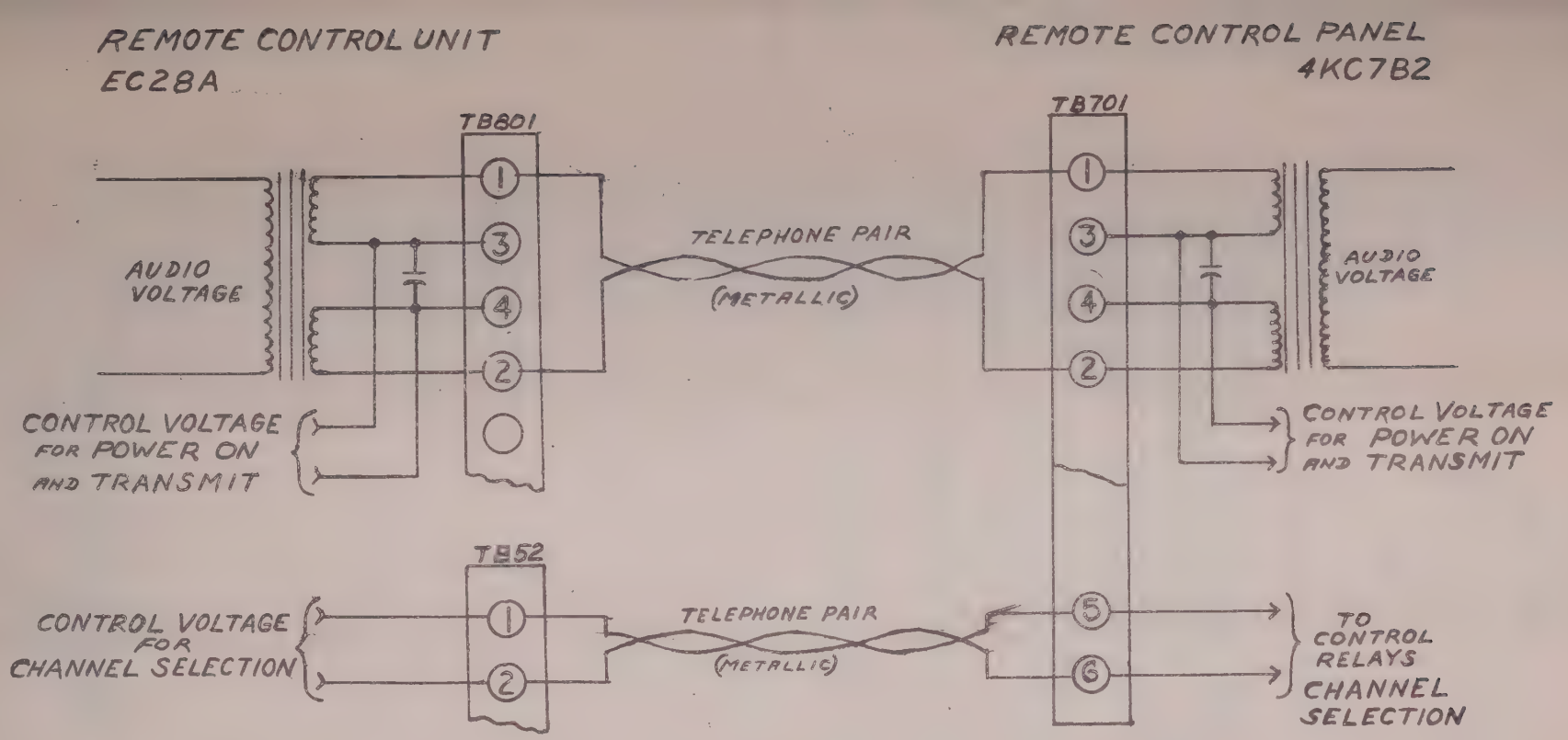

REMOTE CONTROL UNIT
EC28A
REMOTE CONTROL PANEL
4KC7B2
TB801
TB701
AUDIO VOLTAGE
TELEPHONE PAIR
(METALLIC)
AUDIO VOLTAGE
CONTROL VOLTAGE FOR POWER ON AND TRANSMIT
CONTROL VOLTAGE FOR POWER ON AND TRANSMIT
TB52
CONTROL VOLTAGE FOR CHANNEL SELECTION
TELEPHONE PAIR
(METALLIC)
TO CONTROL RELAYS CHANNEL SELECTION

FIGURE 1

:102
tem 3,6

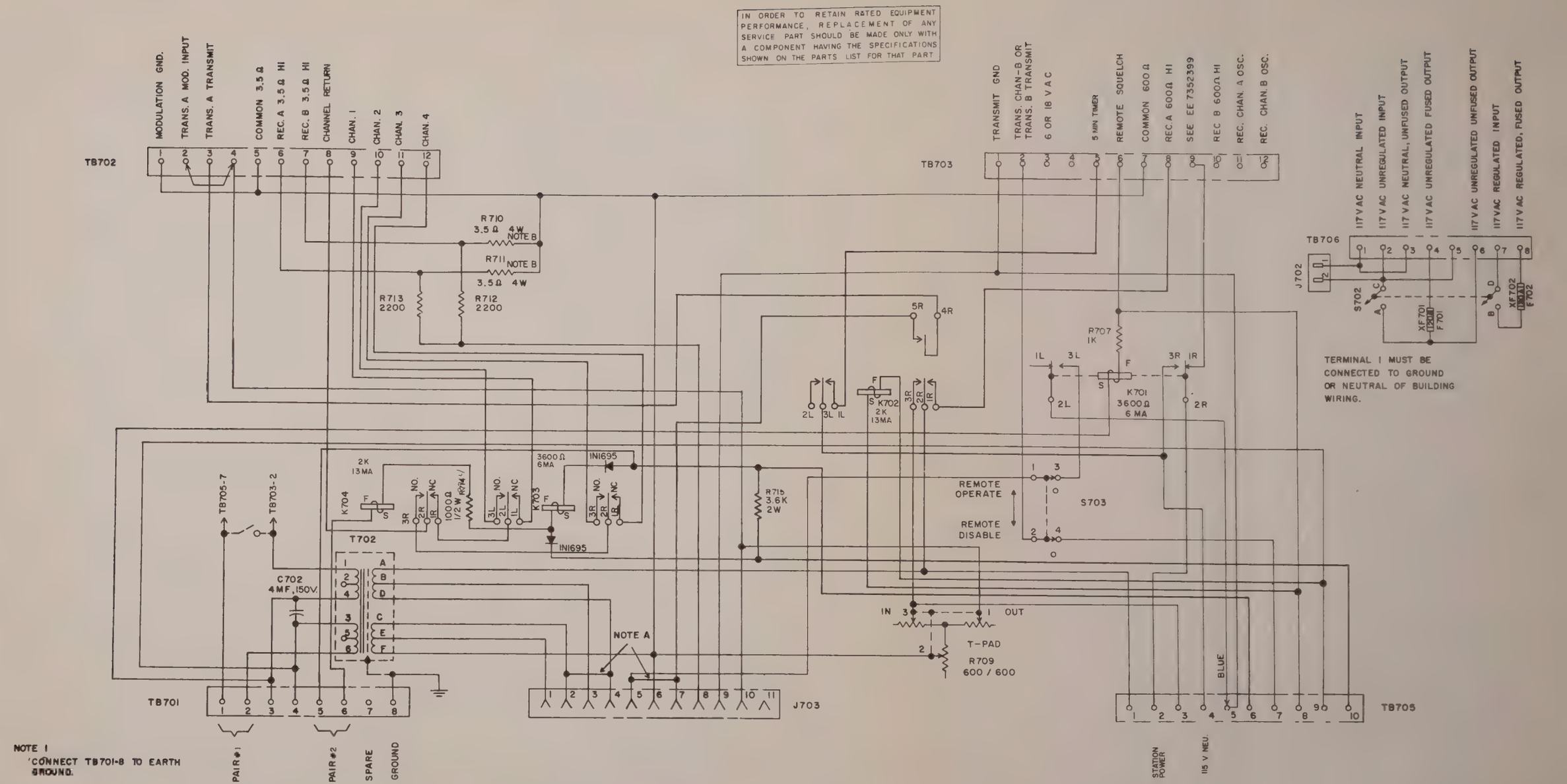
ADDENDUM
TO
EBI-41596

PARTS LIST - 4KC7B2 REMOTE CONTROL PANEL

ADD

Symbol	Description	G-E Drawing and Part No.
K702	Relay; quick acting d-c; resistance 2000 ohms ±10%; pull-in less than 13 ma, dropout more than 7 ma.; twin form A, 1 form C, 1 form D contacts. Magnetic shield cover and guide, assembled.	C-7773760-P15
K703	(Same as K701 - Refer to EBI-41596)	C-7773760-P11
K704	(Same as K702 above)	C-7773760-P15
R714	Resistor; composition, 1000 ohms ±5%, 1/2 w.	C3R77-P102J
R715	Resistor; composition, 3600 ohms ±5%, 2 w.	C3R79-P362J
1N1695	Diode	Type 1N1695

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA



Elementary Diagram

REMOTE CONTROL PANEL
MODEL 4KC7B2 SPECIAL

(D-5498766, Rev. 0)

EBI-41596

PARTS LIST

REMOTE CONTROL PANEL

MODEL 4KC7B2

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	CAPACITORS	
C702	Electrolytic, non polarized, sealed in metal tube, 4 mfd +100% -10%, 150 v d-c w.	B-7486445-P1
	FUSES	
F701 and F702	Cartridge type, 20 amp 250 v, Type 3AG, quick to med blowing. Littelfuse Cat. #314020. Bussman Cat. #ABC-20.	M-7484390-P5
	RECEPTACLES	
J702	10 amp at 250 v, 15 amp at 125 v, Similar to Cinch Cat. #54A12844.	A-7128081-P1
J703	Connector and ring: Mica filled phenolic, 11 female contacts. Cinch Cat. #13786.	A-7140824-P2
	RELAY	
K701	Quick acting d-c, resistance 3600 ohms ± 10%, pull in 6.0 ma or less, dropout 2.0 ma or more, twin 2 form C contacts. Includes magnetic shielding cover and cover guide assembled.	C-7773760-P11
	RESISTORS	
R707	Composition, 1000 ohms ± 10%, 1/2 w.	C-3R77-P102K
R708	Assembly includes: resistor, composition 2000 ohms ± 5%, 2 w, with 2 spade wire terminals. Aircraft Marine Prod. Cat. #41753 or equiv.	A-7141971-G6
R709	Attenuator: T pad, wirewound, 600 ohms imp, 1/2" shaft screw driver control. Mallory Type T600.	P-7772843-P17
R710 and R711	Wirewound, 3.5 ohms ± 10%, 4 w. Clarostat Type C4GY.	K-7131424-P1
R712 and R713	Composition, 2200 ohms ± 10%, 1/2 w.	C-3R77-P222K
	SWITCHES	
S702	Toggle type, dpst, 6 amp at 250 v, 12 amp at 125 v, similar to Arrow Hart and Hegeman Elec. Co. Cat. #82143 except with bat handle.	K-7109677-P1
S703	Toggle type; dpst, 1 amp at 250 v, 3 amp at 125 v. Arrow Hart and Hegeman Type 20902 BJC.	M-7478623-P2
	TRANSFORMER	
T702	Line to line. Rating given at 1000 cycles. Pri imp: 33/200/550/800 ohms ± 10%; sec imp: 33/200/550/800 ohms ± 10%.	C-7775504-P1
	TERMINAL BOARDS	
TB701	8-terminals, #6-32 Philips Pan HD screws. Cinch Cat. #1780.	K-7117710-P8
TB702 and TB703	12-terminals, supplied with Y terminals and terminal screws but without marker strip. HB Jones Cat. #12-164-Y.	C-7774187-P207
TB705	10-terminals, #6-32 Philips Pan HD screws. Cinch Cat. #1799.	K-7117710-P1
TB706	8-terminals, supplied with Y terminals and terminal screws but without marker strip. HB Jones Cat. #8-164-Y.	C-7774187-P205

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	KITS	
Z704	Two-Transmitter Control Kit; includes the following electrical components with Z704 prefix.	PL-7143269-G1
Z704-K1	Quick acting d-c, resistance 2000 ohms ± 10%, pull in less than 13 ma, drop out more than 7 ma, twin 1 form A, 1 form C, and 1 form D contacts. Furnished with magnetic shielding cover and cover guide assembled.	C-7773760-P15
Z704-S1	Toggle type; medium capacity for a-c use only, spdt momentary contacts, solder lug terminals. Cutler Hammer Cat. #7510K5.	B-7487633-P11
Z705	Two-Receiver Control Kit; includes the following electrical components with Z705 prefix.	PL-7143269-G2
Z705-CR1	Selenium, half-wave, 5 cells, forward current 25 ma, peak inverse 184 v, block 90 v d-c. G-E Cat. #GRS20GH5THB1.	B-7487289-P1
Z705-K2	Quick acting d-c, resistance 3600 ohms ± 10%, pull in 6.0 ma or less, dropout 2.0 ma or more, twin 2 form C contacts. Includes magnetic shielding cover and cover guide assembled.	C-7773760-P11
Z705-K3	Quick acting d-c, resistance 2000 ohms ± 10%, pull in less than 13 ma, drop out more than 7 ma, twin 1 form A, 1 form C and 1 form D contacts. Furnished with magnetic shielding cover and cover guide assembled.	C-7773760-P15
Z705-R1	Composition, 1000 ohms ± 10%, 1/2 w.	C-3R77-P102K
Z705-S1	Toggle type; medium capacity for a-c use only, spdt momentary contacts, solder lug terminals. Cutler Hammer Cat. #7510K5.	B-7487633-P11
Z706	Two-Frequency Receiver Control Kit; includes the following electrical components with Z706 prefix.	PL-7143269-G3
Z706-CR1	Selenium, half-wave, 5 cells, forward current 25 ma, peak inverse 184 v, block 90 v d-c. G-E Cat. #GRS20GH5THB1.	B-7487289-P1
Z706-K2	Quick acting d-c, resistance 3600 ohms ± 10%, pull in 6.0 ma or less, drop out 2.0 ma or more, twin 2 form C contacts. Includes magnetic shielding cover and cover guide assembled.	C-7773760-P11
Z706-R2	Composition, 3000 ohms ± 10%, 2 w.	C-3R79-P302K
Z706-S1	Toggle type; medium capacity for a-c use only, spdt momentary contacts, solder lug terminals. Cutler Hammer Cat. #7510K5.	B-7487633-P11
Z707	Intercom-Kit; includes the following electrical components with Z707 prefix.	PL-7488796-G1
Z707-J1	Chassis connector; 4 female contacts. Amphenol Type 91-PC4F.	K-7117934-P2
Z707-P1	Plug and ring, black phenolic, 11 pin contacts, Amphenol Type #86-CP11. Cinch Type #13795. Furnished complete with retaining ring.	B-7478610-P8
Z707-S1	Rotary type; 2 section, 2 positions, 6 pole, non shorting contacts. Oak Type F.	C-7774158-P2
Z707-XB1 and Z707-XB2	Battery holder, to be used with size "D" dry cell flash light battery.	A-7146013-G1
Z708	Relay-Polarizing Kit; includes the following electrical component with Z708 prefix.	PL-7145278-G1
Z708-CR2	Selenium, half-wave, 5 cells, forward current 25 ma, peak inverse 184 v, block 90 v d-c. G-E Cat. #GRS20GH5THB1.	B-7487289-P1

INSTRUCTIONS
FOR
150.8-174 MC RECEIVER FRONT-END ASSEMBLY PL-7150710-G1, REV. D

(WITH ANTENNA ADAPTOR PL-4029757-G1)

Contents

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Block Diagram. RC-398
Service Outline. C-7776413
Elementary Diagram D-7669394
Parts List (see back of Elementary Diagram)

DESCRIPTION

Receiver Front-End Assembly PL-7150710-G1 may be used with wide-band Receiver Models 4ER25B1, 4ER25B2, 4ER25D1 or 4ER25D2 to form a dual-front-end, crystal-controlled receiver for use in mobile radio combinations. Use with narrow-band models 4ER25A1,2,11,12 or 4ER25C1,2,11,12 or with two-frequency models 4ER25B11,12 or 4ER25D11,12 requires special engineering.

When used with a Front-End Assembly, the receiver can be used to monitor two channels, either individually or simultaneously. The normal receiver sensitivity of 0.6 microvolt will not be degraded more than 0.3 microvolt with the receiver and the front-end assembly operating on channels which are farther than 2.0 megacycles apart. Separate antennas should be used to obtain the greatest sensitivity on closely spaced channels.

Antenna Adaptor PL-4029757-G1 is normally supplied with the Front-End Assembly for connecting a second antenna to the Front-End Assembly. The adaptor adds a second antenna jack on the front of the mobile case.

INSTALLATION

When used with a 4-1/2-inch power supply chassis, a 17-inch Mobile Case is required to accommodate the 3-inch by 13-1/2-inch Front-End Assembly, which mounts between the

transmitter and the receiver. With a 1-1/2-inch power supply, the Front-End Assembly can be installed between the receiver and the power supply in a 14-inch case.

FRONT-END ASSEMBLY

To install the Assembly, follow the procedure described on Sheets 1 and 2 of Installation Diagram A-4031704.

ANTENNA ADAPTOR

If a second antenna is to be used, install the Antenna Adaptor on the front panel of the Mobile Case as follows:

1. For trunk-mounted combinations, move the Mobile Transmitter-Receiver nameplate to a position above the lock. Mount the Adaptor in place of the nameplate, with the cable inside.

2. For front-mounted combinations, remove the four screws holding the r-f connector to the Adaptor's mounting plate (except for a-c mobile combinations, in which the plate can be mounted in the unused power plug hole). Use the plate as a template to locate five mounting holes in an unused area on the front of the mobile case. Drill the holes and mount the jack from the inside of the case.

3. Connect the cable from the Adaptor to the Front-End Assembly.

4. Connect the cable from the second antenna to the Adaptor.

ADJUSTMENT

The tuned circuits of the Receiver Front-End Assembly have been precisely aligned at the factory for optimum performance. With the exception of the FRONT END TUNING and the tuning of the High-IF transformer plate circuit (8.7-Mc ALIGNMENT PROCEDURE), the alignment procedure for the dual-front-end receiver is identical to the procedure provided in the standard RECEIVER BENCH ALIGNMENT PROCEDURE.

If the Front-End Assembly was installed at the factory and the system frequencies were known, it should only be necessary to tune the Antenna Transformers for maximum quieting. Otherwise, it will be necessary to retune the front-end stages of the receiver, as described below.

EQUIPMENT REQUIRED

1. A non-metallic screw driver.

2. A 20,000 ohm-per-volt voltmeter with a 0-3 volt scale or a microammeter with an 0-50 and 0-500 microampere scale (GE Test Set Type EX-1-C or equivalent).

3. A signal generator with a 144-174 megacycle range, such as Measurements Corp. Model 80, General Radio 1021AV or a Boonton 202-C.

PROCEDURE

1. Check the 1st Oscillator crystals to be sure that the proper crystals are being employed in the proper sockets. The 1st Oscillator crystal controlling the Channel A injection frequency should be inserted between pins 4 and 6 of XY301 on the Receiver. The 1st Oscillator crystal controlling the Channel "B" injection frequency should be inserted between pins 4 and 6 of XY2312 of the Receiver Front-End Assembly.

2. Turn the receiver on and allow it to warm up for at least five minutes. Check to see that the battery or supply voltage is normal (6.6 or 13.2 volts d-c).

3. Ground both 1st Oscillator cathodes. This may be done by placing the microphone or handset on the hookswitch in the hang-up position or by jumpering TB15-1 and 2 (on underside of receiver chassis - See Service Outline for location) to ground.

4. Follow steps 3 thru 9 of the FRONT END TUNING procedure in the RECEIVER BENCH ALIGNMENT PROCEDURE for tuning the front end on the receiver chassis.

5. Connect a microammeter having a 0-500 microampere full scale range or a 0-3 volt, 20,000 ohm-per-volt voltmeter between the OSC-1 jack, J2313 (green-negative), on the Receiver Front-End Assembly and ground.

6. Tune the oscillator tank coil Z2312-L1 on the Receiver Front-End Assembly for maximum grid metering voltage indication. If there is any doubt about being on the correct peak, turn the adjustment fully counterclockwise and then clockwise to the first peak. Note the reading and turn the core counterclockwise until the meter reads 80% of the maximum grid metering voltage or 1.4 volts which ever is lower. A minimum of about 1.1 volts should be obtained after tuning for 80% of the maximum with a standard supply voltage of 6.6 for 13.2 volts d-c or 117 volts a-c to the power supply. The 1.4 volt equivalent microammeter reading, when using an EX-1-C meter or equivalent, will be 365 microamperes.

7. Move the meter probe to the MULT jack, J2317 (green-negative) on the Receiver Front-End Assembly.

8. Peak the top and bottom slugs of T2315 (L1 and L2). The peak meter reading should be 0.7 volts (0-3 voltmeter) or 30 microamperes (microammeter) or more.

9. Move the meter probe to the DISC. jack, J304 on the receiver chassis.

WARNING

The recessed adjustment for ceramic trimmer capacitor C1 of transformer T2316 is in the B+ circuit. Exercise caution around this capacitor.

10. Set trimmer C1 and C3 of T2316 to approximately the correct positions as follows: At high end of receiver range (152 Mc on 4ER25B1,11 or 174 Mc on 4ER25B2,12) the trimmer should be set at MIN (use dot of solder on ceramic part of rotor as pointer. Maximum capacity will be realized when the pointer lies toward the capacitor mounting screws and on a line perpendicular to a line joining the two mounting screws. Minimum capacity will be obtained by rotating the rotor 180° away from maximum). At low end of receiver range (144 Mc on 4ER25B1 or 11 or 152 Mc on 4ER25B2 or 12), the trimmer should be set at maximum. Adjust proportionably for mid-frequencies.

11. Connect signal generator to pin 7 of XV2314 on the Receiver Front-End Assembly. Using maximum generator output, zero the generator to discriminator zero. This zeroing should coincide with an increase in (LIM-1) meter indication.

12. Move the meter probe to the LIM-1 jack, J302 on receiver chassis.

13. Reduce the signal generator output until the LIM-1 meter indicates below saturation, but above noise. Peak both trimmers of T2316 (C1 and C3).

14. Peak the plate circuit of the High IF transformer, T303A-L1 (see 8.7 Mc Alignment Procedure of RECEIVER BENCH ALIGNMENT PROCEDURE for locating L1).

15. Move the signal generator to pin 1 of XV2313. With the Generator adjusted to zero discriminator and the output below limiting, peak the T2314 trimmers marked RF on the Receiver Front-End Assembly (C2329 and C2327). Peak the grid circuit before the plate circuit.

16. If the channels are separated by more than 4.0 megacycles, move the signal generator to the antenna jack (J2311 on the Receiver Front-End Assembly labeled TO TRANS).

17. Adjust the generator to the Channel B discriminator zero and peak the Receiver Front-End Assembly Antenna Transformer (T2313) trimmers (C3 on the bottom of the transformer and C1 on top of the transformer). Always peak C3 (bottom trimmer) first and then peak C1 (top trimmer).

NOTE

Depending upon the receiver operating frequency, maximum LIM-1 current and maximum quieting may not occur together. Where this is the case, always tune for maximum quieting, as noted either on an output meter or by the response of the speaker if no output meter is available. Keep the input signal level from the signal generator low.

18. Adjust the generator to the Channel A discriminator zero and peak the receiver's Antenna Transformer (T301 or T322) trimmers, C1 and C3. As before, peak C3 (the bottom trimmer) first.

19. If the channels are separated by less than 4.0 megacycles and the best sensitivity is desired, connect the signal generator directly to the antenna transformer (J1 on T2313). Disconnect W2319 and W2312.

20. Adjust the generator to the Channel B discriminator zero and peak the Receiver Front-End Assembly Antenna Transformer (T2313) trimmers (C3 on the bottom of the transformer and C1 on top of the transformer). Always peak C3 (bottom trimmer) first and then peak C1 (top trimmer).

21. Move the signal generator to the receiver's antenna jack (J1 on T301 or T322).

22. Adjust the generator to the Channel A discriminator zero and peak the receiver's Antenna Transformer (T301 or T322) trimmers, C1 and C3. As before, peak C3 (the bottom trimmer) first.

23. Disconnect the signal generator and reconnect W2319 and W2312. Do not tune the antenna transformers after this step.

REVISION LETTER CHANGES

The changes listed below are identified by the letter appearing in the REV pad on the unit nameplate.

REV. A

Part Changed	Was	Changed To
C2316	Capacitor, Ceramic: temp compensating, tubular; 18 mmfd ± 10%, 500 v d-c w. -80 temp coef. G-E Part No. P-7770468-P212.	Deleted.

Elementary Diagram Changes

"C2316, 18" was deleted.

Purpose for Change

To improve sensitivity.

REV. B

Part Changed	Was	Changed To
XY2312	Crystal socket: octal, with ring, mica filled phenolic. Cinch Cat.#9865. G-E Dwg. No. A-7140823-P2.	Crystal socket: octal, with ring, mica filled phenolic with 2 diametrically opposed keyways. Similar to Cinch Cat. #51E16871. G-E Dwg. No. A-7147225-P1.
R2313	Resistor: composition, 33,000 ohms ± 10%, 1/2 w. G-E Dwg.No.C-3R77-P333K.	Resistor: composition, 150,000 ohms ± 10%, 1/2 w. G-E Dwg. No. C-3R77-P154K.

Purpose of Changes

XY2312 was changed to permit use of heated crystals without modifications.

R2313 was changed to equalize RF gain of dual front end and associated high band receiver.

REV. B (Cont'd)

Elementary Diagram Changes

Remove wires showing unheated crystal wiring.

Change value of R2313 from 33,000 ohms to 150,000 ohms.

REV. C

Part Changed	Was	Changed To
R2313	Resistor: composition 150,000 ohms ± 10% 1/2 w. G-E Dwg.No.C-3R77-P154K.	Resistor: composition 68,000 ohms ± 10% 1/2 w. G-E Dwg. No. C-3R77-P683K.

Purpose of Change
R2313 was changed to increase RF gain.

Elementary Diagram Changes

Changed value of R2313 from 150,000 ohms to 68,000 ohms. TB4 was changed to TB9.

R2313 which was connected between C2330 and TB4 is now connected between TB5-3 and TB9-2. C2330 is now connected to TB9-2.

REV. D - To extend frequency range from 152-174 Mc to 150.8-174 Mc.

Part Changed	Was	Changed To
C2315	Capacitor, ceramic: Hi-K disk: 0.0015 mfd +100% -0%, 500 v d-c w. G-E Part No. C-7774750-P5.	Capacitor, ceramic disk: 6000 mmfd ± 20%, 500 v d-c w. G-E Part No. C-5494481-P19.
C2322	Capacitor, ceramic: Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. G-E Part No. B-7488160-P1.	Capacitor, ceramic disk: 6000 mmfd ± 20%, 500 v d-c w. G-E Part No. C-5494481-P19.

REV. D (Cont'd)

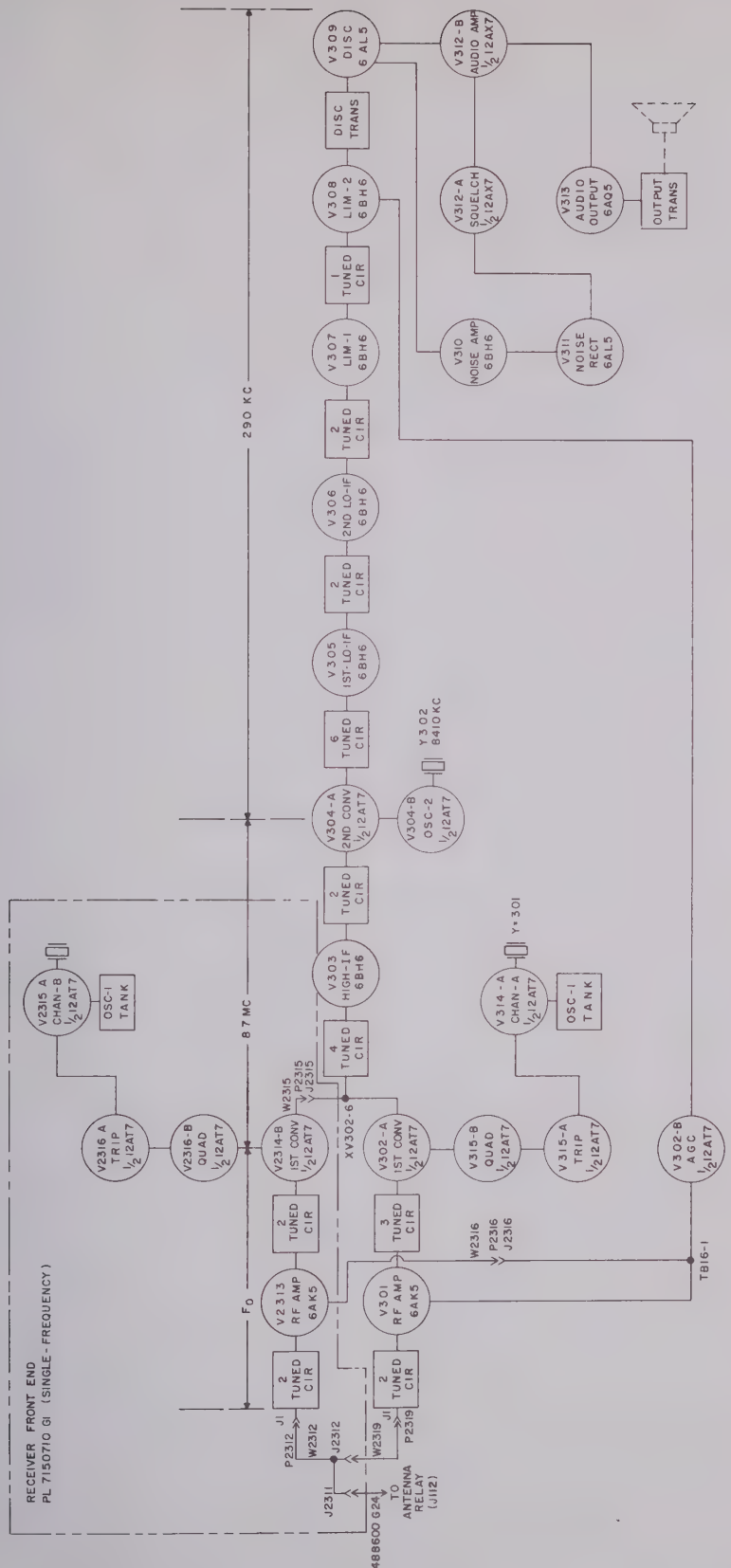
Part Changed	Was	Changed To
T2313	Transformer, antenna. G-E Part No. PL-7144650-G1.	Transformer, antenna. G-E Part No. PL-7144650-G3.
T2313-C1 and T2313-C3	Capacitor, variable air: 1.98 to 7.83 mmfd, 1250 v peak. G-E Part No. M-7481115-P2.	Replaced by T2313-C8 and T2313-C9.
T2313-C8 and T2313-C9	Added in place of T2313-C1 and T2313-C3.	Capacitor, variable air: 2.13 to 8.73 mmfd, 1250 v peak. G-E Part No. M-7481115-P13.

Elementary Diagram Changes

C2322 was changed from .01 mfd to .006 mfd.
C2315 was changed from 1500 mmfd to .006 mfd.
In antenna transformer T2313, C1 (1.8-8.7 mmfd) was changed to C8 (2.0-9.0 mmfd) and C3 (1.8-8.7 mmfd) was changed to C9 (2.0-9.0 mmfd).

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
ELECTRONICS PARK

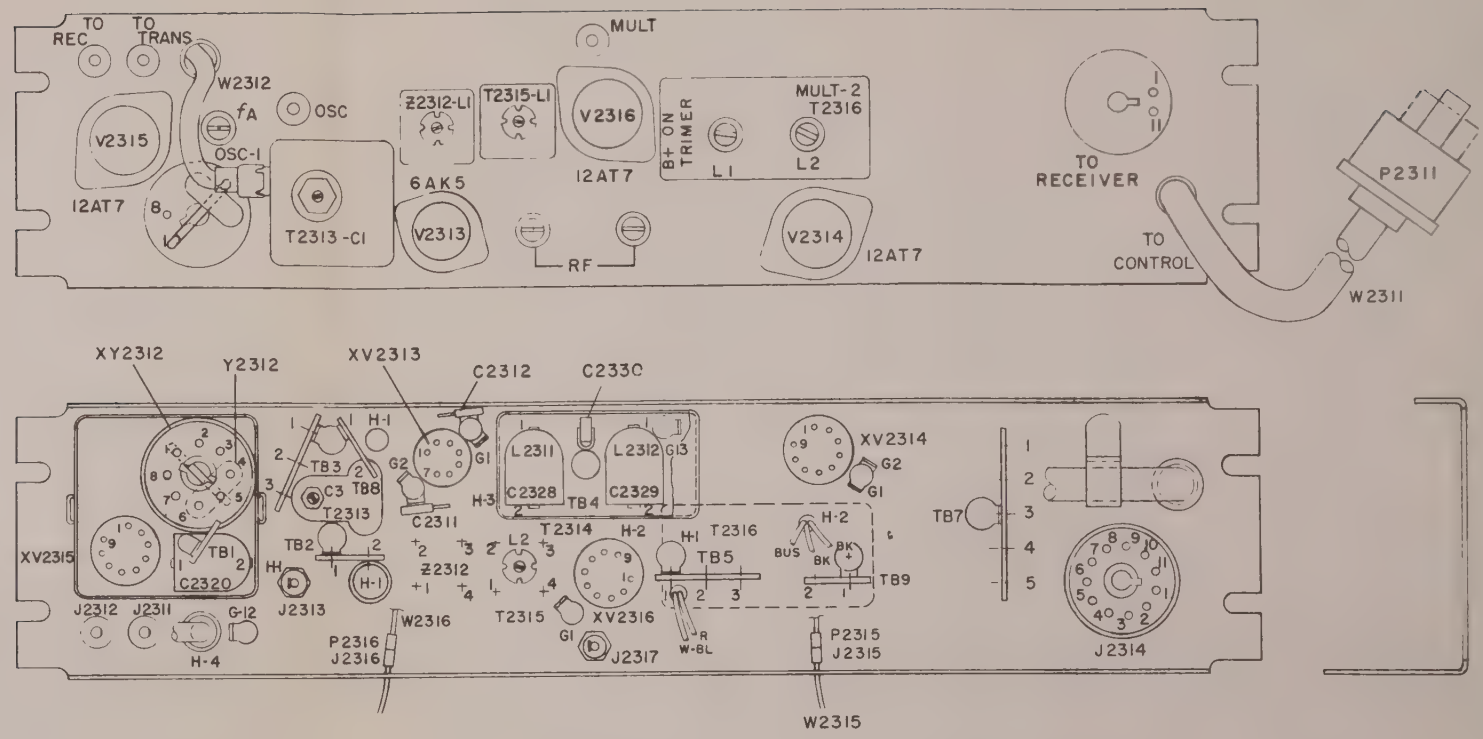
50EP6 Printed in U.S.A.

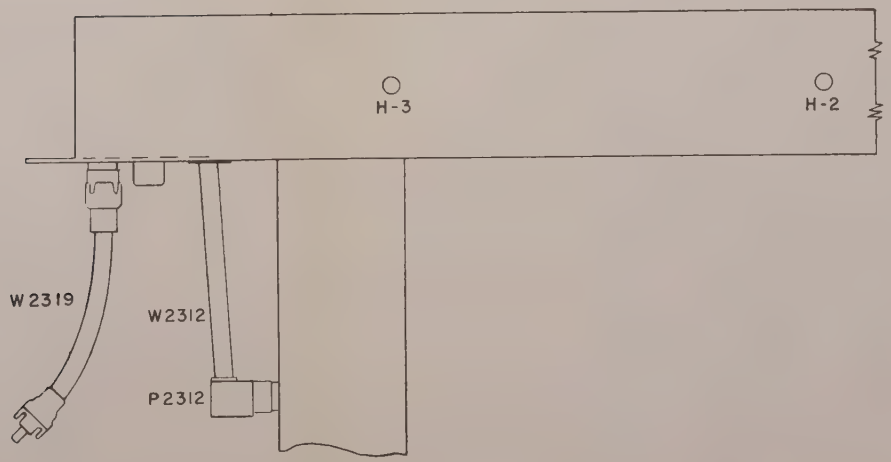


Block Diagram

DUAL FRONT-END RECEIVER
MODELS 4ER25B1,2

(RC-398B)

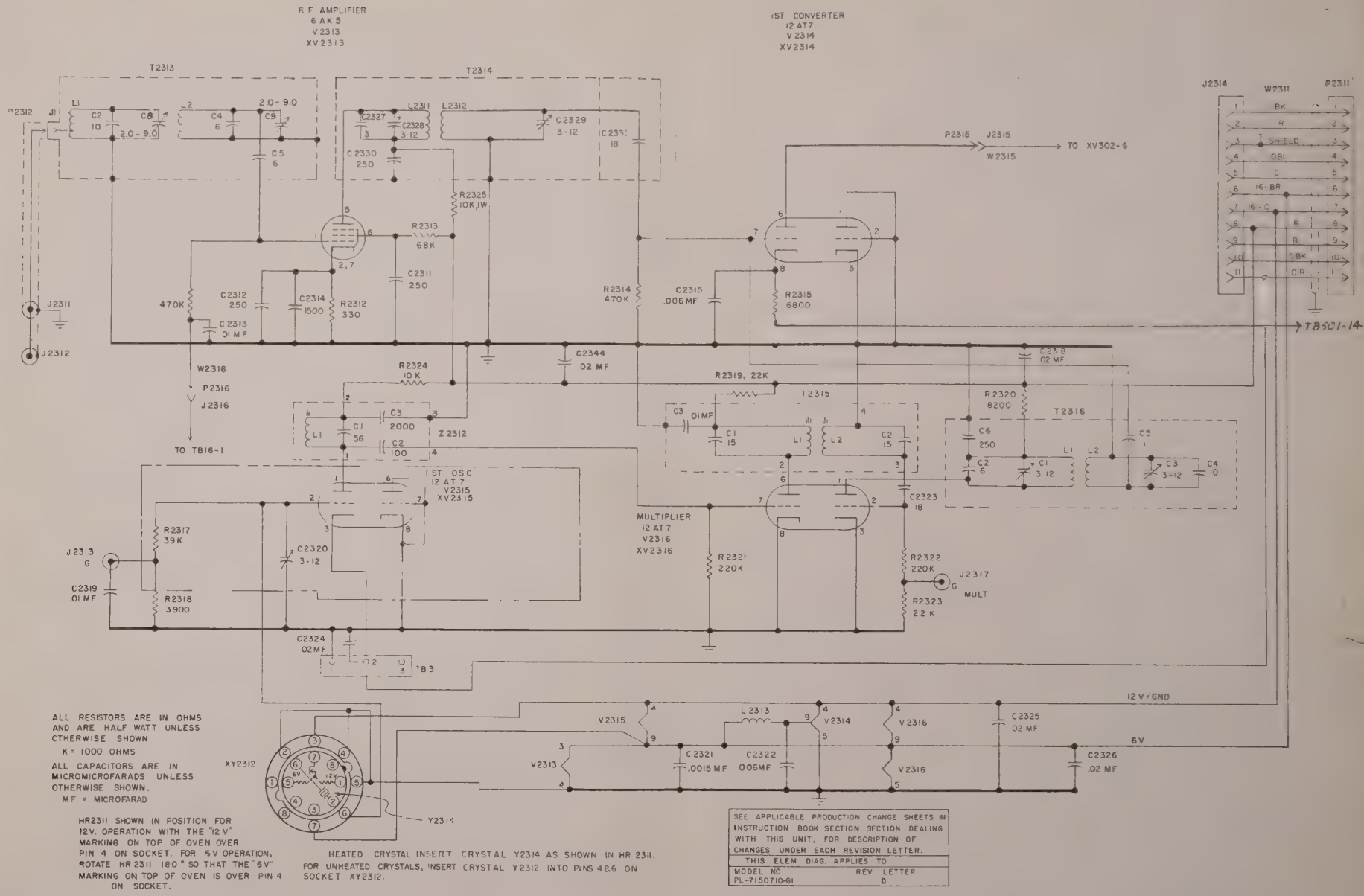




Service Outline

RECEIVER FRONT-END ASSEMBLY PL-7150710-G1

(C-7776413, Rev. 2)



ALL RESISTORS ARE IN OHMS AND ARE HALF WATT UNLESS OTHERWISE SHOWN
K = 1000 OHMS

ALL CAPACITORS ARE IN MICROMICROFARADS UNLESS OTHERWISE SHOWN.
MF = MICROFARAD

HR2311 SHOWN IN POSITION FOR 12V. OPERATION WITH THE "12 V" MARKING ON TOP OF OVEN OVER PIN 4 ON SOCKET. FOR 6V OPERATION, ROTATE HR 2311 180° SO THAT THE "6V" MARKING ON TOP OF OVEN IS OVER PIN 4 ON SOCKET.

HEATED CRYSTAL INSERT CRYSTAL Y2314 AS SHOWN IN HR 2311. FOR UNHEATED CRYSTALS, INSERT CRYSTAL Y2312 INTO PINS 4 & 6 ON SOCKET XY2312.

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

THIS ELEM. DIAG. APPLIES TO

MODEL NO.	REV. LETTER
PL-7150710-G1	D

Elementary Diagram

150.8-174 MC RECEIVER FRONT-END ASSEMBLY PL-7150710-G1, REV. D

(D-7669394, Rev. 8)
SPECIAL

EBI-41242F

PARTS LIST

FOR

150.8-174 MC RECEIVER FRONT-END ASSEMBLY

PL-7150710-G1, REV. D

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	CAPACITORS	
C2311 and C2312	Uncased, mica, 250 mmfd ± 10%, 500 v d-c w. Underwood Type J-1-MF modified.	PL-7146331-G1
C2313	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C2314	Ceramic, Hi-K disk; 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C2315#	Ceramic disk, insulated; 6000 mmfd ± 20%, 500 v d-c w. RMC Corp. Type JF Discap. Changed by Rev. D.	C-5494481-P19
C2316#	Deleted by Rev. A.	
C2318	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C2319	Ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
C2320	Ceramic, variable; 3.0 to 12.0 mmfd, 500 v d-c w. Erie Type TS2A-NPO.	M-7484389-P2
C2321	Ceramic, Hi-K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	C-7774750-P5
C2322#	Ceramic disk, insulated; 6000 mmfd ± 20%, 500 v d-c w. RMC Corp. Type JF Discap. Changed by Rev. D.	C-5494481-P19
C2323	Ceramic, temp compensating, tubular; 18 mmfd ± 10%, 500 v d-c w, -80 temp coef.	P-7770468-P212
C2324 thru C2326	Ceramic, Hi-K disk, 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
C2327	Ceramic, temp compensating, tubular; 3.0 mmfd ± 0.25 mmfd, 500 v d-c w, -220 temp coef.	P-7770468-P434
C2328 and C2329	Ceramic, variable; 3.0 to 12.0 mmfd, 500 v d-c w. Erie Type TS2A-NPO.	M-7484389-P2
C2330	Uncased mica, 250 mmfd ± 10%, 500 v d-c w. Underwood Electric Type J-1-MF modified.	PL-7133474-G3
C2331	Ceramic, temp compensating, tubular, 18 mmfd ± 10%, 500 v d-c w, -80 temp coef.	PL-7770468-P212
C2344	Ceramic, Hi-K disk; 0.02 mfd +80% -20%, 450 v d-c w. Centralab Type DA-145.	B-7488160-P2
	CRYSTAL OVEN	
HR2311	Crystal oven for use with 85°C crystals. Used with Y2314.	B-5490303-P1
	JACKS AND RECEPTACLES	
J2311 and J2312	Connectors; phono type, mica filled phenolic. Similar to Cinch Cat. #14H20190 except silver plated.	K-7104941-P7
J2313	Test point jack; stake in, molded nylon. Alden Products Co. Type 110BC1-green.	A-7150763-P4
J2314	Connector and ring, 11 female contacts, black phenolic. Cinch Cat. #13783.	A-7140824-P1
J2315	Connector, part of Cable W2315.	
J2316	Connector, part of Cable W2316.	
J2317	Test point jack; stake in, molded nylon. Alden Products Co. Type 110BC1-green.	A-7150763-P4
	INDUCTORS	
L2311 and L2312	RF Transformer coils.	A-7141042-P1
L2313	RF choke coil: inductance 5.6 uh ± 10%. Jeffers Cat. #10203-20.	B-7488079-P40
	PLUGS	
P2311	Plug, part of cable W2311.	
P2312	Plug, part of cable W2312.	
P2315	Plug, part of cable W2315.	
P2316	Plug, part of cable W2316.	
	RESISTORS	
R2311	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3R77-P474K
R2312	Composition, 330 ohms ± 10%, 1/2 w.	C-3R77-P331K
R2313#	Composition, 68,000 ohms ± 10%, 1/2 w. Changed by Rev C.	C-3R77-P683K
R2314	Composition, 0.47 megohm ± 10%, 1/2 w.	C-3R77-P474K
R2315	Composition, 6800 ohms ± 10%, 1/2 w.	C-3R77-P682K
R2317	Composition, 39 000 ohms ± 10%, 1/2 w.	C-3R77-P393K
R2318	Composition, 3900 ohms ± 10%, 1/2 w.	C-3R77-P392K
R2319	Composition, 22,000 ohms ± 10%, 1/2 w.	C-3R77-P223K
R2320	Composition, 8200 ohms ± 10%, 1/2 w.	C-3R77-P822K
R2321 and R2322	Composition, 0.22 megohm ± 10%, 1/2 w.	C-3R77-P224K
R2323	Composition, 22,000 ohms ± 10%, 1/2 w.	C-3R77-P223K
R2324	Composition, 10,000 ohms ± 10%, 1/2 w.	C-3R77-P103K
R2325	Composition, 10,000 ohms ± 10%, 1 w.	C-3R76-P103K
	TRANSFORMERS	
T2313#	Antenna, includes the following components with T2313 prefix. Changed by Rev. D.	PL-7144650-G3
T2313-C2	Capacitor: ceramic, temp compensating, tubular; 10 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P241
T2313-C4	Capacitor: ceramic temp compensating tubular; 6.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P237
T2313-C5	Capacitor: ceramic, insulated, temp compensating; 6.00 mmfd ± 0.25 mmfd, 500 v d-c w, -80 ± 60 temp coef.	B-7488184-P5
T2313-C8# and T2313-C9#	Variable air; 2.13 to 8.73 mmfd, 1250 v peak.	M-7481115-P13
T2313-J1	Connector: phono type, mica filled phenolic. Similar to Cinch Cat. #14H20190 except silver plated.	K-7104941-P7
T2313-L1 and T2313-L2	Coils: 6.5 turns per inch, right hand wound, 0.47 inches ID ± 0.01 inches.	A-7145404-P1
T2314	RF Transformer, consists of C2327, C2328, C2329, C2330, C2331, L2311, L2312 and R2325.	
T2315	1st Multiplier coil; includes the following components with T2315 prefix.	PL-7486460-G1
T2315-C1 and T2315-C2	Capacitors: ceramic disk, insulated temp compensating, 15 mmfd ± 5%, 500 v d-c w, -80 temp coef.	C-7774846-P244
T2315-C3	Capacitor: ceramic, Hi-K disk; 0.01 mfd +80% -20%, 450 v d-c w. Centralab Type DA-048.	B-7488160-P1
T2316	Second Multiplier; includes the following components with T2316 prefix.	PL-7144727-G1
T2316-C1	Capacitor, ceramic, variable; 3.0 to 12.0 mmfd, 500 v d-c w. Erie Type TS2A-NPO.	M-7484389-P2
T2316-C2	Capacitor: ceramic, temp compensating, tubular, 7.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P238
T2316-C3	Capacitor: ceramic, variable; 3.0 to 12.0 mmfd, 500 v d-c w. Erie Type TS2A-NPO.	M-7484389-P2
T2316-C4	Capacitor: ceramic, temp compensating, tubular; 10 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P241
T2316-C5	Capacitor: ceramic, temp compensating tubular; 1.0 mmfd ± 0.25 mmfd, 500 v d-c w, -80 temp coef.	P-7770468-P231
T2316-C6	Capacitor: uncased mica, 250 mmfd ± 10%, 500 v d-c w. Underwood Electric Type J-1-MF modified.	K-7133474-G3
T2316-L1 and T2316-L2	Coils: 1.50 turns, right hand close wound, #16 Awg, copper magnet wire, single coated vinyl acetal.	A-7145524-P1
	TUBES	
V2313	Type 6AK5.	
V2314 thru V2316	Type 12AT7.	
	CABLES	
W2311	Cable assembly includes; connector with 11-male contacts, black phenolic plug (G-E Dwg and Part No. A-4031521-P1), with metal cap metal stamped with the letter "R", (G-E Dwg and Part No. A-4031219-P1); or an 11-pin male plug, green, molded type with the letter "R" molded in the connector, Component Mfg. Service Cat. #1601-M11.	B-7489384-P1
W2312	Cable assembly: includes 5.00 inches of RG-58A/U cable, black, with a short pin silver plated phone plug molded on one end.	B-7488600-P89
W2315 and W2316	Cable assembly: includes the following PL-7147206-G7 and G8 which consists of two 1.42 inches ± 0.06 inches of #27 Awg, 7 stranded, teflon insulated hookup wire, color white, G-E Dwg. No. A-7144127-P10 with male connector Winchester Electronic Cat. #21803, G-E Dwg. No. A-7147199-P1 and female connector Winchester Electronics Cat. #21804, G-E Dwg. No. A-7147199-P2.	PL-7146762-G6
W2319	Cable assembly: includes 4.75 inches of RG-58A/U cable with a short pin silver plated phone plug molded on one end.	B-7488600-P2
	SOCKETS	
XV2313	Tube socket, mica filled phenolic, 7 pin miniature, top mount, flat top. RETMA Type TSE7T201.	P-7768887-P9
XV2314 thru XV2316	Tube socket, mica filled phenolic, 9 pin miniature. RETMA Type TSE-9T-201.	M-7480532-P3
XY2312#	Crystal socket and ring; octal, mica filled yellow and black phenolic with 2 diametrically opposed keyways. Similar to Cinch Cat. #51E16871. Changed by Rev B.	A-7147225-P1
	CRYSTALS	
	When reordering give G-E Dwg. and Part No. and specify exact frequency needed. Crystal frequency = (operating frequency -8.7 Mc) ÷ 12.	
Y2312	One unheated crystal.	B-7488901-P1
Y2314	One 85°C heated crystal for use with crystal oven HR2311.	B-7488901-P5
	FILTERS	
Z2312	Tank, first oscillator; includes the following components with Z2312 prefix.	PL-7488670-G2
Z2312-C1	Capacitor: ceramic disk, insulated, temp compensating, 56 mmfd ± 5%, 500 v d-c w, -150 temp coef.	C-7774846-P357
Z2312-C2	Capacitor: ceramic disk, insulated temp compensating; 100 mmfd ± 10%, 500 v d-c w, -750 temp coef.	C-7774846-P621
Z2312-C3	Capacitor: ceramic, stabilized Hi-K disk; 2000 mmfd ± 10%, 500 v d-c w. Radio Material Corp Type JL.	C-3R81-P202K

SPEAKER MOUNTING PANEL (Special)

The Speaker Mounting Panel contains the 4EZ1B1 Speaker, a 0-3 volt milliameter with test lead, and a Fenwal Thermoswitch. Components are wired in accordance with Elementary Diagram B-5492716 and function as outlined below.

Model 4EZ1B1 Speaker

Station Audio is applied to the speaker circuit through terminals TB1-5 and 6, and controlled by toggle switch S3. When S3 is "ON", station audio is applied to the speaker voice coil; in the "OFF" position, audio is removed and replaced with a 3.5 ohm dummy load (R1).

Test Meter

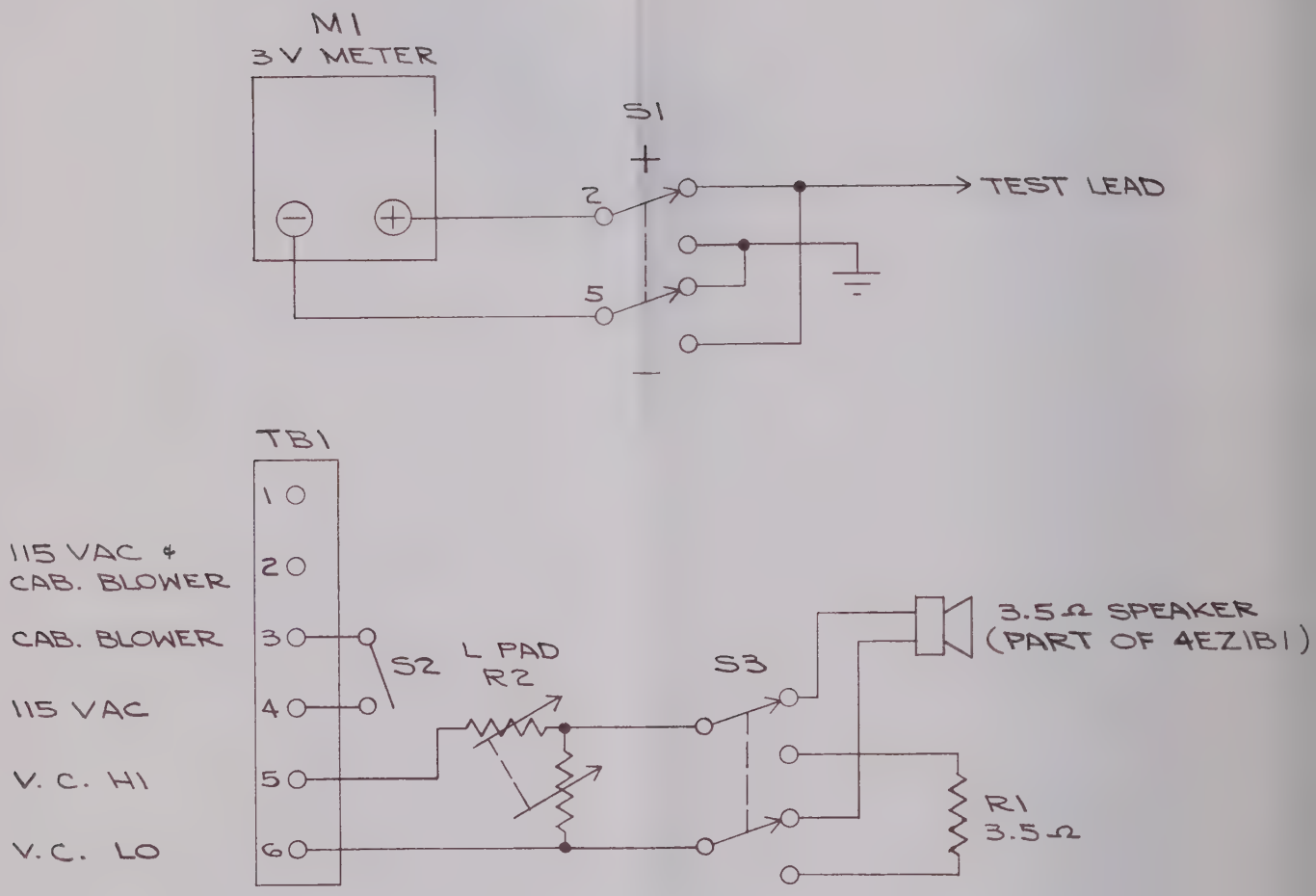
A 0-3 volt, 50 ma. d-c meter facilitates aligning and tuning the Transmitter and Receiver circuits. The meter terminals are connected to a dpdt switch (S1), which reverses the polarity between the single test lead and chassis ground.

Fenwal Thermoswitch

The Thermoswitch (S2) controls the 115 volt a-c power supply to the Cabinet Blower Motor, and operates at approximately 75°F. The two wires from the Blower Motor must be connected to TB1-2 and 3.

PARTS LIST

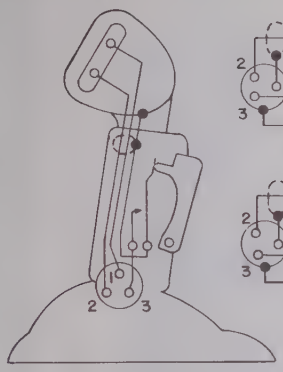
Symbol	Description	G-E Part No.
R1	Resistor, wire-wound; 3.5 ohms, ±10%, 4 w. Clarostat Type C4GJ	K-7131424
R2	Attenuator L pad: 3.5 ohms, 4 w, Max attenuation 36 db (Part of 4EZ1B1 Speaker).	M-7478301-P8
S1	Switch, slide, dpdt, 0.5 amp at 125 v. Stackpole Cat. No. SS-150	A-7145098-P1
S2	Thermoswitch, spst, temp. range -100°F to +400°F. Fenwal Cat. No. 17301	
S3	Switch, toggle, dpdt, 1 amp at 250 v, 3 amp at 125 v, non-inductive. Arrow-Hart & Hegeman 20905-BJC	M-7478623-P4
M1	Meter, 3-1/2" sq: 60,000 ohms ±10%, 0-3 vdc, 50 MA linear scale, 60 divisions. Solder lug terminals. Triplett Mod. 327-PL	
LS101	Speaker, dynamic, 4" permanent magnet: 4 w, voice call impedance 3.2 ohms. G-E Type S400C22	M-7485089-P1

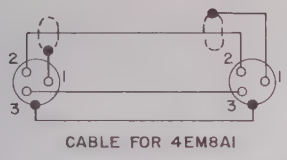


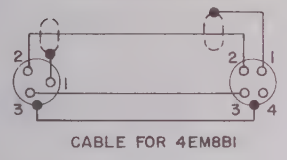
Elementary Diagram

SPEAKER MOUNTING PANEL SPECIAL

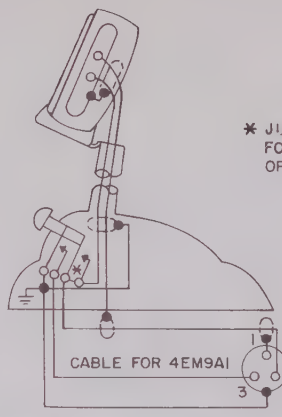
(B-5492716, Rev. 0)



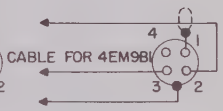




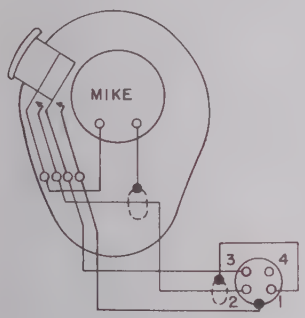
DESK MICROPHONE MODELS 4EM8AI,BI



* JUMPER MAY BE REMOVED FOR PARALLEL OR SPECIAL OPERATION.

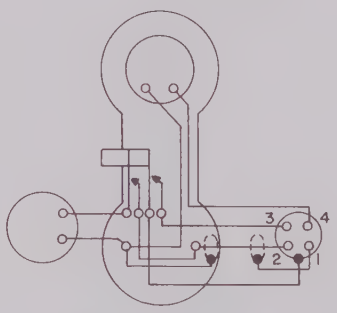


DESK MICROPHONE MODELS 4EM9AI, BI



MILITARY TYPE MICROPHONE

MODELS 4EMIOAI AND 4EMIOBI

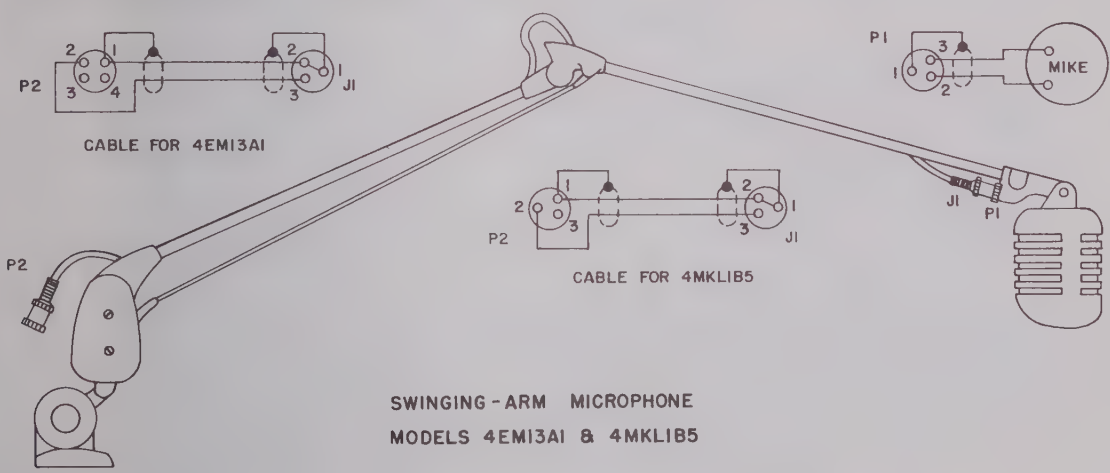


TELEPHONE HANDSET

MODEL 4EMI2AI

CABLE FOR 4EMI3AI

CABLE FOR 4MKLIB5



SWINGING-ARM MICROPHONE

MODELS 4EMI3AI & 4MKLIB5

Elementary Diagram

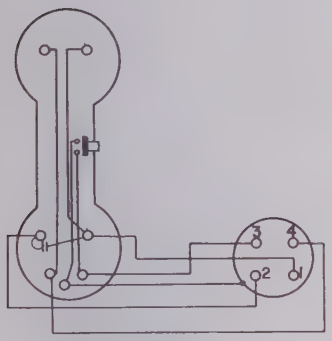
CONTROLLED-RELUCTANCE MICROPHONES

(RC-302D)

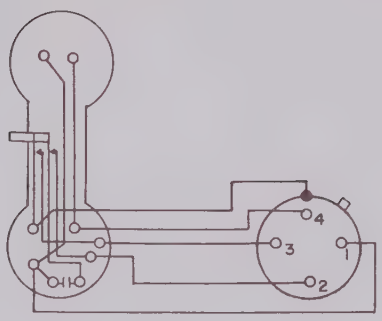
PARTS LIST
FOR
CONTROLLED-RELUCTANCE MICROPHONES

SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	DESK MICROPHONE MODEL 4EM8A1, B1	
	Microphone, controlled reluctance, Shure Bros. Model CR-41 microphone with Model S-36A desk stand, and Type A88A switch modified. Includes plastic or rubber covered, 3 conductor, one under shield cable. Shure Bros. Cable Spec #15A303A, 3 pin male plugs. Amphenol Type 91-MC3M. Used in 4EM8A1. Must have 33-485 Mu-Metal ring and 66A35 rubber mounting ring assembled.	M-7485051-P1
	Microphone controlled reluctance. Shure Bros. Model CR-41B microphone with Model S-36A desk stand, and Type A88A switch modified. Includes plastic or rubber covered, 3 conductor, one under shield, cable. Shure Bros. Cable Spec #15A303A, 3 pin male plug. Amphenol Type 91-MC3M. Has end of cable away from mike 4 pin male plug Amphenol Cat. #91-MC4M. Used in 4EM8B1. Must have 33-485 Mu-Metal ring and 66A35 rubber mounting ring assembled.	M-7485051-P2
	DESK MICROPHONE MODEL 4EM9A1, B1	
	Microphone and stand, controlled reluctance type. Shure Bros. Model CR-88. Load impedance 100,000 ohms approx, output 52.5 db below one volt per microbar. Includes 3 conductor, one under shield, plastic covered cable. Shure Bros. Cable Spec #15A303A, 3 pin male plug Amphenol Type #91-MC3M. Used with 4EM8A1. Must have 65A68 plastic acoustic cup assembled.	C-7774958-P1
	Microphone and stand, controlled reluctance type. Shure Bros. Model CR-88B. Load impedance 100,000 ohms approx, output 52.5 db below 1 v per microbar. Includes 3 conductor, one under shield, plastic covered cable. Shure Bros. Cable Spec #15A303A, 3 pin male plug Amphenol Type #91-MC3M and a connector Amphenol Type #91-MC4M. Used in 4EM9B1. Must have 65A68 plastic acoustic cup assembled.	C-7774958-P2
	MILITARY MICROPHONE MODEL 4EM10A1	
	Microphone, hand, controlled reluctance: high impedance output at least 55 db below 1 v per microbar per 1 KC, includes 3 conductor, with one under shield, retractile tinsel cord. Shure Bros. Cable Spec #15A407A, 12" retracted length, and one 4 pin Amphenol plug Cat. #MC4M. Cable with 2 connectors assembled, Shure Bros. Spec #90H262. Must have 33-485 Mu-Metal ring and 66A35 rubber mounting ring assembled.	B-7488422-P1
	Clip.	PLA-7141414-G1
	MOISTURE-PROOF MILITARY MICROPHONE MODEL 4EM10B1	
	Microphone, hand, controlled-reluctance: high impedance output at least 55 db below 1 v per microbar per 1 kc, includes 3-conductor retractile tinsel cord with one conductor under shield. Shure Bros. Cable Spec #15A407A, 12" retracted length, and one 4-pin Amphenol plug Cat. #MC4M. Cable with 2 connectors assembled, Shure Bros. Spec. #90H262. Switch and all connections moisture-proofed. Must have 33-485 Mu-Metal ring and 66A35 rubber mounting ring assembled.	B-7488422-P2
	HANDSET MODEL 4EM12A1	
	Telephone handset with controlled reluctance transmitter. Includes Receiver Unit, Shure Bros. #99A148. Transmitter unit Shure Bros. #99A86. Cable: 4 conductor, one under shield, tinsel coiled cord with tangent ends. Shure Bros. Cable Spec. #15A407A, one male plug Amphenol Type 91-MC4M. Cable with 2 connectors assembled, Shure Bros. Spec #90L262.	B-7486495-P1
	Handset holder. W.E. Type KS-10080.	K-7101608-P4

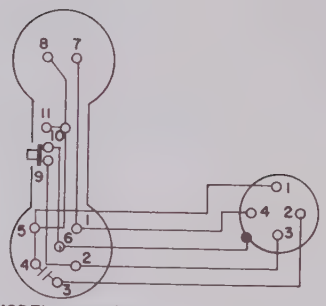
SYMBOL	DESCRIPTION	G-E DRAWING & PART NO.
	SWINGING-ARM MICROPHONE MODEL 4EM13A1	
	Microphone, multi-impedance, dynamic: moving coil type with freq range of 50 to 15,000 cps, has swivel adjustment from 0 to 80°. Shure Bros. Model 55S (DY12).	B-7487533-P1
	Microphone bracket: 24" reach, includes shielded two conductor rubber or PVC jacketed microphone cable, Belden Cat. #8412, 2 amphenol plugs Type 91 MC3M. Dazor Mfg. Co. Cat. MP-866. Also has 4 pin connector amphenol Type 91-MC4M on cable end away from mike.	C-7774934-P2
	SWINGING-ARM MICROPHONE MODEL 4MKL1B5	
	Microphone, multi-impedance, dynamic: moving coil type with freq range of 50 to 15,000 cps, has swivel adjustment from 0 to 80°. Shure Bros. Model 55S (DY12).	B-7487533-P1
	Microphone bracket: 24" reach, includes shielded two conductor rubber or PVC jacketed microphone cable, Belden Cat. #8412. 2 Amphenol plugs Type 91-MC3M. Dazor Mfg. Co. Cat. #MP-866.	C-7774934-P1



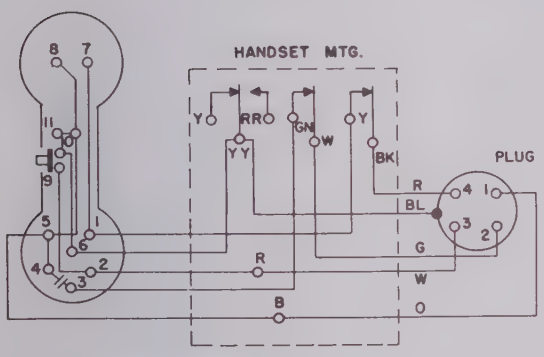
MODEL 4EM6A1



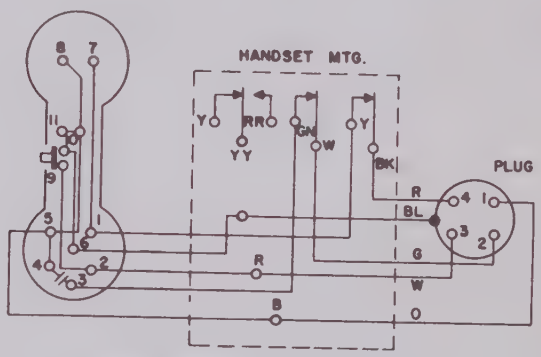
MODEL 4EM11A1, 2



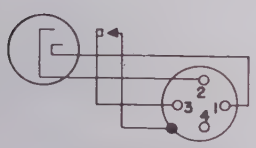
MODEL 4MKH1A3,5



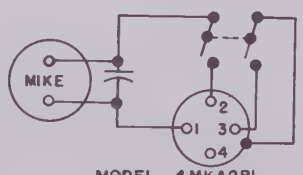
MODEL 4MKD3A1



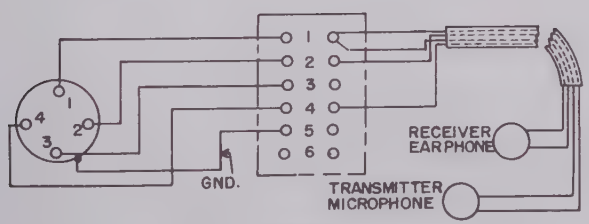
MODEL 4MKD3A3,4



MODEL 4MKA2A5,6,7



MODEL 4MKA2B1



MODEL 4EM5B1

50ER26

Elementary Diagrams

CARBON MICROPHONES

(RC-173D, 174D)

DESCRIPTION	G-E DRAWING AND PARTS NO.
CARBON MICROPHONES	
Model 4EM5B1	
Headset, operators. Western Elec. Type 52-AWS less plug. Includes Transmitter unit. W.E. No. N-1. Receiver unit. W.E. No. HC-1. Cord, 5 ft. W.E. No. L4AG. Transmitter arm. W.E. No. 55-AW. Receiver holder. W.E. No. 10A. Head band. W.E. No. 15A. Head band pad. W.E. No. P-477139.	M-7474914-P1
Cord: 5 conductor, includes one 4 pin male Amphenol plug Cat. #91-MC4M.	PL-7480008-G1
Models 4EM11A1 and 2	
Telephone handset, with carbon transmitter. Includes Transmitter unit. Western Elec. No. F-1 or Roanwell #10037 Receiver unit. Roanwell No. RA1. Switch. Roanwell No. 10164. Cable: 5 conductor coiled tinsel cord with tangent ends, one Amphenol Type 91-MC4M. (4EM11A1 only.)	B-7486451-P1
Telephone handset, with carbon transmitter. Includes Transmitter unit. Western Elec. No. F1. Receiver unit. Roanwell No. RA1. Switch. Roanwell No. 10164. Cable. 5 conductor stranded cord, one Amphenol plug Type 91-MC4M. (4EM11A2 only.)	B-7486451-P2
Handset holder. WE Type KS-10080.	K-7101608-P4
Models 4MKA2A5, 6 and 7	
Microphone, hand, carbon: Shure Model CB10E finished with Shure #4A27, retractile 4 conductor tinsel cord. (4MKA2A5 only.)	M-7484746-P2
Microphone, hand, carbon: Shure Model CB10S finished with Shure No. 4A27, straight tinsel cord, 4 conductor, 6 ft. long. (4MKA2A6 only.)	M-7484746-P3
Microphone, hand, carbon: Shure Model CB-50 with cartridge #99A149 and 4 conductor #23GA retractile cord, mtg hardware deleted. (4MKA2A7 only.)	M-7484746-P4
Clip. (4MKA2A5 and 7 only.)	PLA-7141414-G1
Model 4MKA2B1	
Microphone, hand, carbon. Electro-Voice Model 205, Spec #565. RETMA sensitivity rating 123 db, impedance available 100 ohms, sliding contacts of on-off switch open microphone circuit in off position includes: 4 conductor unshielded, tinsel wire, rubber jacketed, coil cord, 12 retracted; one 4 contact male cable connector Amphenol Cat. #MC-4M. Microphone has hangup button and is supplied less mtg clip.	B-7487545-P2
Model 4MKD3A3	
Handset: Western Elec. Type F3WW-3, less cord. Includes Transmitter unit. W.E. No. F1. Receiver unit. W.E. No. HA6. Condenser. W.E. No. 129F.	K-7101608-P1
Handset mounting: Western Elec. Type G7-3.	M-7473283-P2
Handset cord: 4 ft long.	PL-7477113-G4
Hang up mtg. cord: 6 ft. long, includes one Amphenol plug Type 91-MC4M.	PL-7477113-G5
Model 4MKH1A3	
Handset; Western Elec. Type F3WW-3, less cord. Includes Transmitter unit. W.E. No. F1. Receiver unit. W.E. No. HA6. Condenser. W.E. No. 129F.	K-7101608-P1
Handset holder. Western Elec. Type KS10080.	K-7101608-P4
Cord Assembly: includes 33 turns of 5 conductor retractile coiled cord, #23, one Amphenol plug Type 91-MC4M.	K-7133977-G1

DESCRIPTION	G-E DRAWI AND PARTS
Model 4MKD3A4	
Handset: Western Elec. Type F3WW-3, less cord. Includes Transmitter unit. W.E. No. F1. Receiver unit. W.E. No. HA6. Condenser. W.E. No. 129F.	K-7101608
Handset mounting. Western Elec. Type G2-3.	M-7473283
Handset cord, retractile: Kellogg 5 conductor tinsel cord, 10 spade terminals, 14-3/4" overall retracted length.	M-7477098
Hang up mtg. cord: 6 ft long, includes one Amphenol Plug Type 91-MC4M.	PL-747711
Model 4MKH1A5	
Handset: Western Elec. Type F3WW-3, less cord Includes Transmitter unit. W.E. No. F1. Receiver Unit. W.E. No. HA6. Condenser. W.E. No. 129F.	K-7101608
Handset holder. Western Elec. Type KS10080.	K-7101608
Retractile cord: 33 turns of Kellogg 5 conductor coiled cord #23 rubber covered, includes one 4 pin male plug Amphenol Type 91-MC4M.	M-7477098

CAPACITOR AND RESISTOR COLOR CODE CHART

GEI-18964F

RESISTORS
FIXED COMPOSITION
EIA STANDARD RS-172
MILITARY SPECIFICATION MIL-R-11

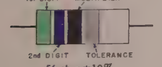
Color	Digits of Resistance (ohms)	Multiplier	Tolerance (%)
Black	0	1	—
Brown	1	10	—
Red	2	100	—
Orange	3	1000	—
Yellow	4	10,000	—
Green	5	100,000	—
Blue	6	1,000,000	—
Violet	7	10,000,000	—
Gray	8	100,000,000	—
White	9	—	—
Gold	—	0.1	±5
Silver	—	0.01	±10
No color	—	—	±20

INSULATION CODING

Insulated fixed composition resistors with axial leads are designated by a background of any color except black. The usual color is natural tan. Non-insulated resistors with axial leads are designated by a black background color. Noninsulated resistors with radial leads are designated by a black background color or by a background the same color as the first significant figure of the resistance value.

EXAMPLES

AXIAL LEADS



56 ohms ±10%

RADIAL LEADS (OBSOLETE)

4700 ohms ±10%

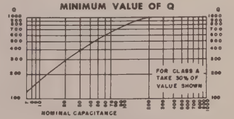
CAPACITORS
MICA DIELECTRIC
EIA STANDARD RS-153
(See example under MIL-C-5A)

Color	Digits of Capacitance (μμf)	Class	Multiplier	Tolerance (%)
Black	0	A	1	±20
Brown	1	B	10	±1
Red	2	C	100	±2
Orange	3	D	1000	±3
Yellow	4	E	10,000	—
Green	5	—	—	±5
Blue	6	—	—	—
Violet	7	—	—	—
Gray	8	—	—	—
White	9	—	—	—
Gold	—	—	0.1	—
Silver	—	—	0.01	±10

DESCRIPTION OF CLASS

Class	Temperature Coefficient (parts per million per °C)	Maximum Capacitance Drift	Minimum Insulation Resistance (megohms)
A	±1000	±(5% +1 μμf)	3000
B	±500	±(3% +1 μμf)	6000
C	±200	±(0.5% +0.5 μμf)	6000
D	±100	±(0.3% +0.1 μμf)	6000
E	+100 −20	±(0.1% +0.1 μμf)	6000

MINIMUM VALUE OF Q

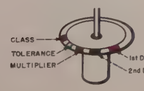


VOLTAGE RATING
(Indicated by dimensions rather than color coding)

Maximum Dimensions (inches) Length	Width	Thickness	Style	Capacitance (μμf)	Voltage Rating (v d-c)
35/64	5/16	7/32	15	5–270	500
				300–510	300
51/64	15/32	7/32	20	5–510	500
				560–1000	300
1 7/64	15/32	7/32	25	5–1000	500
				1100–1500	300
53/64	23/64	9/32	30	470–6200	500
				Over 6200	300
53/64	23/64	5/8	35	3300–6200	500
				Over 6200	300
1 1/32	41/64	13/32	40	100–2400	1000
				2700–7500	500
				Over 7500	300

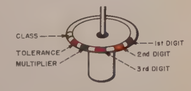
EXAMPLES

SILVER MICA BUTTON CAPACITORS (5-DOT)



700 μμf ± 5%, Class C

SILVER MICA BUTTON CAPACITORS (6-DOT)



1320 μμf ± 2%, Class E

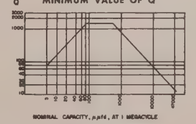
CAPACITORS
MICA DIELECTRIC
MILITARY SPECIFICATION MIL-C-5A

Color	Digits of Capacitance (μμf)	Characteristic	Multiplier	Tolerance (%)
Black	0	—	1	±20(M)
Brown	1	B	10	—
Red	2	C	100	±2(G)
Orange	3	D	1000	—
Yellow	4	E	—	—
Green	5	F	—	—
Blue	6	—	—	—
Violet	7	—	—	—
Gray	8	—	—	—
White	9	—	—	—
Gold	—	—	0.1	±5(J)
Silver	—	—	—	±10(K)

DESCRIPTION OF CHARACTERISTIC

Characteristic	Temperature Coefficient (parts per million per °C)	Maximum Capacitance Drift	Minimum Insulation Resistance (megohms)
B	Not specified	Not specified	7500
C	±200	±0.5%	7500
D	±100	±0.3%	7500
E	+100 −20	±(0.1% +0.1 μμf)	7500
F	0 to +70	±(0.05% +0.1 μμf)	7500

Q MINIMUM VALUE OF Q



VOLTAGE RATING
(Indicated by dimensions rather than color coding)

Maximum Dimensions (inches) Length	Width	Thickness	Style CM	Capacitance (μμf)	Voltage Rating (v d-c)
35/64	5/16	7/32	15	5–510	300
51/64	15/32	7/32	20	5–510	500
				560–1000	300
1 7/64	15/32	7/32	25	51–1000	500
53/64	25/64	9/32	30	560–3300	500
53/64	25/64	23/64	35	3600–6300	500
				6800–10,000	300
1 3/64	21/32	23/64	40	3300–8200	500
				9100 & 10,000	300

EXAMPLE
6-DOT CODE

510 μμf ± 2%, Characteristic C, 500 v (Style CM20)

The arrangement of dots under EIA Standard RS-153 is the same as in the example above. The only difference is that the *first* dot is *white* instead of black.

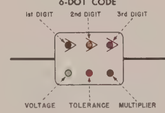
CAPACITORS
MICA DIELECTRIC
OBSOLETE STYLES

Color	Digits of Capacitance (μμf)	Multiplier	Tolerance (%)	Voltage Rating (v d-c)
Black	0	1	±20	
Brown	1	10	±1	100
Red	2	100	±2	200
Orange	3	1000	±3	300
Yellow	4	10,000	±4	400
Green	5	—	±5	500
Blue	6	—	±6	600
Violet	7	—	±7	700
Gray	8	—	±8	800
White	9	—	±9	900
Gold	—	0.1	±5*	1000
Silver	—	0.01	±10	2000
No color	—	—	±20*	500*

*Old 3-dot only.

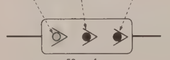
EXAMPLES

6-DOT CODE



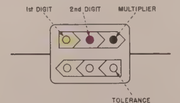
1320 μμf ± 2%, 500 v

3-DOT CODE



50 μμf
(Voltage rating is always 500 v; tolerance is always 20%.)

3-DOT CODE (OLD RMA)



47 μμf
(Voltage rating is always 500 v; tolerance is always 20%.)

CAPACITORS
CERAMIC DIELECTRIC
EIA STANDARD RS-198
MILITARY SPECIFICATION MIL-C-20B

Color	Digits of Capacitance (μμf)	TC Multiplier *	Multiplier	Tolerance 10 μμf or Less (μμf)	Tolerance Over 10 μμf (%)	Nominal Temperature Coefficient (parts per million per °C) EIA	Nominal Temperature Coefficient (parts per million per °C) MIL	% Max Cap. Chng Over Temperature Range *	Temperature Range (°C) *
Black	0	−1	1	±2.0	±20	0	0	±2.2	—
Brown	1	−10	10	±0.1*	±1	−33	−30	±3.3	+10 +85
Red	2	−100	100	—	±2	−75	−80	±4.7	—
Orange	3	−1000	1000	—	±3*	−150	−150	±7.5	—
Yellow	4	−10,000	10,000*	—	+100 −0*	−220	−220	±10	—
Green	5	+1	—	±0.5	±5	−330	−330‡	±15	—
Blue	6	+10	—	—	—	−470	−470	±22	—
Violet	7	+100	—	—	—	−750	−750	+22 −33	—
Gray	8	+1000	0.01	±0.25	+80 −20	+150 to −1500	—	+22 −56	—
White	9	+10,000	0.1	±1.0	±10*	+100 to −750	‡	+22 −82	—
Gold	—	—	—	—	—	—	+100	±1	−55 +85
Silver	—	—	—	—	—	—	—	±1.5	−30 +85

* EIA only. ‡ White for Characteristic SL.

EXAMPLES

6-DOT DISC CAPACITORS—EIA CLASS I (TEMPERATURE COMPENSATED)

1500 μμf ±5%, −75 temperature coefficient

TUBULAR CAPACITORS
(MIL units with radial leads have dots)

2200 μμf ± 5%, 0 temperature coefficient

(Voltage rating is always 500 v.)

TUBULAR CAPACITORS (OLD RMA)

4700 μμf ± 2%, 0 temperature coefficient

STAND-OFF CAPACITORS (EIA ONLY)

250 μμf ± 5%, 0 temperature coefficient

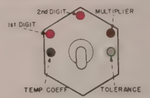
6-DOT DISC CAPACITORS—EIA CLASS II (GENERAL PURPOSE)

1000 μμf −0+100%, Max. ΔC ±15% from −10 to +85° C

3-DOT BUTTON CAPACITORS (OLD RETMA)

1000 μμf

FEED-THROUGH CAPACITORS (EIA ONLY)



220 μμf ± 5%, 0 temperature coefficient

5-DOT DISC CAPACITORS (EIA ONLY)

1500 μμf ± 5%, −75 temperature coefficient

3-DOT DISC CAPACITORS (OLD RETMA)

510 μμf
(Voltage rating is always 500 v; tolerance is always −0.)

CAPACITORS
PAPER DIELECTRIC
MILITARY SPECIFICATION MIL-C-91A
(Commercial codes are same except as noted)

Color	Digits of Capacitance (μμf)	Multiplier	Tolerance (%)	Voltage Rating* (v d-c)	Characteristic	Temperature Rating (°C)
Black	0	1	±20	—	A	85
Brown	1	10	—	100	E	85
Red	2	100	—	200	—	—
Orange	3	1000	±30	300	—	—
Yellow	4	10,000	—	400	—	—
Green	5	—	—	500	—	—
Blue	6	—	—	600	—	—
Violet	7	—	—	700	—	—
Gray	8	—	—	800	—	—
White	9	—	—	900	—	—
Gold	—	—	—	1000	—	—
Silver	—	—	±10	—	—	—

*Tubular capacitors only; for rectangular capacitors see table below.

VOLTAGE RATING FOR RECTANGULAR CAPACITORS
(Indicated by dimensions rather than color coding)

Maximum Dimensions (inches) Length	Width	Thickness	Style CN	Capacitance (μμf)	Voltage Rating (v d-c)
53/64	15/32	7/32	20	1000	400
				2000–6000	200
				10,000	120
57/64	37/64	17/64	22	2000 & 3000	400
				6000 & 10,000	200
				20,000	120
53/64	53/64	9/32	30	1000 & 2000	800
				3000	600
				6000 & 10,000	400
				20,000	120
55/64	53/64	11/32	35	3000	800
				6000 & 10,000	600
				20,000	300
1 3/64	41/64	9/32	41	3000 & 6000	600
				10,000	400
				20,000	300
				30,000	120
1 15/32	45/64	13/32	42	1000–6000	1000
				10,000–20,000	600
				30,000	400
				50,000	300
				100,000	120
1 15/32	45/64	13/32	43	10,000	1000
				20,000 & 30,000	600
				50,000 & 100,000	400
				200,000	120

EXAMPLES

TUBULAR CAPACITORS (COMMERCIAL ONLY)

15,000 μμf ± 20%, 400 v
(No characteristic or temperature rating)

RECTANGULAR CAPACITORS

3000 μμf ± 10%, Characteristic A

GENERAL ELECTRIC
SCHENECTADY, NEW YORK

GENERAL INFORMATION

The following information has been included to assist the customer and serviceman in the use of this instruction book.

NAMEPLATE INFORMATION

General Electric Radio Communication Equipment is identified by a nameplate attached to the case or chassis of the unit. Typical nameplates currently in use are shown in Fig. 1 and Fig. 2.

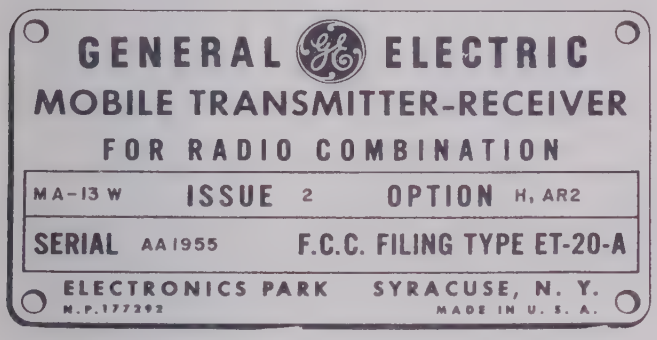


Fig. 1 Mobile Transmitter-Receiver Nameplate

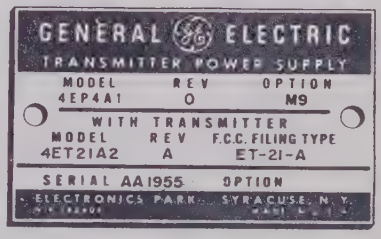


Fig. 2 Station Transmitter Nameplate

"TYPE" numbers (such as Transmitter Type ET-20-A in Fig. 1) describe general classes of equipment and are used only for broad identification and, in the case of transmitters, for FCC filing.

"MODEL" numbers (such as Power Supply Model 4EP4A1 and Transmitter Model 4ET21A2 in Fig. 2) describe units in more detail than their type numbers and are essential for proper identification.

The "REV" letter indicates what production changes have been made on the unit. When the unit has a nameplate, the revision letter is stamped on the nameplate. Otherwise, the revision letter follows the model number stamped on the chassis of the unit.

The "OPTION" pad on the nameplate is stamped with one or more letters indicating the optional modifications that have been added to the equipment. The "M9" stamped in the "OPTION" pad in the nameplate in Fig. 2, for example, indicates that the transmitter power supply has been modified for the use of a carbon microphone.

When writing for service parts, service information, etc. for a particular unit, the customer should give the model number, revision letter and option letters of the unit, as indicated in the following example:

Transmitter: Model 4ET21A2, Rev. A, Option none

The "COMBINATION" number (such as "MA-13-W" in Fig. 1) describes the complete mobile or station combination. The "ISSUE" number indicates what models of equipment are in the combination. A new issue number is used each time one or more of the units in the combination changes model number. The "SERIAL" numbers are provided for the convenience of the customer in identifying his transmitters.

PRODUCTION CHANGES

From time to time, changes are made to the production equipment described in this book, either to improve performance or to simplify circuits. Any change made on a production unit will be assigned a Revision Letter, which will be stamped after the model number of the unit on the nameplate or on the chassis. A Revision Letter system is used as a means of identifying equipment and recording the changes made. Any given revision will always include all previous revisions.

A Production Change Sheet is located at the front of the section of the instruction book covering a unit that has been revised. This sheet lists the changes in the instruction book necessitated by each revision made on the unit. The Production Change Sheets should be used for checking and/or correcting instructional material to correspond with the revision/s of the equipment being serviced.

SERVICE PARTS

A list of all principal service parts for each unit of this equipment is included in the section of the book covering the unit. The symbol numbers used are the same as those appearing on the elementary diagram and other drawings.

Service parts may be obtained from authorized G-E Service Stations or ordered through any G-E Communications Equipment District Sales Office (see list of sales offices on last page). When ordering a part, please include the symbol number, description, and drawing number of the part and the model number and revision letter stamped on the unit.

SAFETY NOTICE

Since the use of high voltages is necessary for the successful operation of the radio equipment described in this instruction book, certain reasonable precautions must be carefully observed by the operating personnel during the installation, operation and maintenance of the equipment.

Although every practicable safety measure has been incorporated in this equipment, the following rule must be strictly observed:

WARNING

Under no circumstances should any person be permitted to handle any portion of the equipment that is supplied with high voltage, or to connect any external apparatus to the units while the units are supplied with power. KEEP AWAY FROM LIVE CIRCUITS.

FCC COMPLIANCE OF TRANSMITTER

In order to provide guaranteed performance, radio transmitters are usually designed with maximum performance characteristics which exceed somewhat the nominal ratings of the unit. The user should be certain to adjust the equipment in accordance with the rules and regulations of the radio transmission regulatory body to which he is subject. These rules usually include, for any particular service, the following:

1. Maximum power input to the final RF stage: Calculate the power input in watts by multiplying the plate voltage on the PA tube by the plate current in amperes. If the plate current cannot be measured directly and the cathode current is used instead, grid currents may be subtracted from the cathode current to

obtain the plate current. In most cases, the screen grid current cannot be metered conveniently, but can be calculated by dividing the voltage across the screen resistor by the resistance of the screen resistor. If maximum power output, rather than power input, for the final RF stage is to be measured, use a wattmeter to measure the power.

2. Maximum modulation: While monitoring the transmitter output with a modulation monitor, set the modulation control for maximum allowable deviation while the audio limiters in the transmitter have a saturating signal.

3. Frequency check: Measure the frequency of the unmodulated carrier at the required intervals and, if necessary, set the transmitter back on frequency.

The other characteristics of the transmitter which are not adjustable have been designed to comply with the rules and regulations of the principal radio transmission regulatory bodies in effect at the time of manufacture. Listings of G-E Equipment approved for use in various services can usually be obtained through the regulatory body, as well as information on current regulations which may come into effect after the initial equipment licensing.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the nearest General Electric Company District Sales Office.

COMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA

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Requests for service information and orders for replacement parts not obtainable from a local radio dealer may be directed to the nearest office listed below or to the General Electric Company, Communication Products Department, Carroll Ave., Lynchburg, Virginia (Att: Service Parts Department).

ALABAMA		
BIRMINGHAM	608 Brown-Marx Bldg.	FAirfax 2-6844
ARIZONA		
PHOENIX	1102 North 22nd Avenue	ALpine 8-6721
ARKANSAS		
LITTLE ROCK	115 North State St.	FRanklin 2-1159
CALIFORNIA		
LOS ANGELES 24,	1722 Westwood Blvd.	BRadshaw 2-0948 or GRanite 3-0928
REDWOOD CITY	565 Broadway	EMerson 8-4681
SAN RAFAEL	2052 4th Street	GLenwood 6-2366
COLORADO		
DENVER	3775 Grove Street	GEnesee 3-6391
DISTRICT OF COLUMBIA		
WASHINGTON	927 Wyatt Bldg., 777-14th St., N. W.	EXecutive 3-3600
FLORIDA		
POMPANO BEACH	Room 207, Professional Bldg., 2641 Atlantic Blvd.	WEbster 3-8838
TALLAHASSEE	Suite 201, Petroleum Bldg., Bronough & Pensacola Sts.	4-5434
TAMPA	420 W. LaFayette Street, Room 222	8-1918
GEORGIA		
ATLANTA	Suite 1B-Luckie Bldg., 359-361 E. Paces Ferry Rd.,N.E.	CEdar 3-8879 or CEdar 3-5493
ILLINOIS		
GLENVIEW	600 Waukegan Rd.	GLenview 4-8633
INDIANA		
FORT WAYNE	606 West Superior Street	EAstbrook 7615
INDIANAPOLIS 8,	3750 N. Meridian Street, Room 107	WAlnut 5-9633
IOWA		
CEDAR RAPIDS	220 Dows Building	EMpire 5-0481
LOUISIANA		
METAIRIE	3305 Metairie Rd., P. O. Box 605	VErdon 5-5792
MARYLAND		
BALTIMORE 4,	762-C Fairmount Ave., Towson Plaza	VA 5-4900
MASSACHUSETTS		
WELLESLEY	471 Washington Street	CEdar 5-4654 or 5-5104
MICHIGAN		
DETROIT	16247 Wyoming Avenue	DIamond 1-1459
LANSING	Room 1107, Bank of Lansing Bldg.	IVanhoe 2-4827
MINNESOTA		
EXCELSIOR	Tonka Bldg., 2nd & Water St.	GReenwood 4-5948
MINNEAPOLIS	3280 Gorham Avenue	WEst 9-4622
MISSOURI		
KANSAS CITY	2826 Main Street	VAlentine 1-7561
		VAlentine 1-0224
ST. LOUIS 17,	1808 South Hanley	MIssion 7-6350 or 7-6351
NEBRASKA		
LINCOLN	Room 902, Sharp Bldg.	2-1936
NEW YORK		
LIVERPOOL	Charles Annex, 914 Old Liverpool Rd.	OLdfield 2-2531 or OLdfield 2-2532
NEW ROCHELLE	Room 819, 271 North Ave.	3-7012
NORTH CAROLINA		
CHARLOTTE	Room 116, Builders Bldg., 314 West Trade Street	FRanklin 5-5244
RALEIGH	Room 204 - Cameron Village, 400 Oberlin Rd., Box 10534	VAnce 8-4186
NORTH DAKOTA		
BISMARCK	Room 20, 1st Federal Savings & Loan Bldg., 410-1/2 Thayer Avenue	CApitol 3-8111
OHIO		
CINCINNATI	1514 Robinway Drive, P. O. Box 1536	BEachmont 1-1050
CLEVELAND	Room 218 Suburban-West Bldg., 20800 Center Ridge Rd.	EDison 1-8851
COLUMBUS 14,	4292 Indianola Avenue	AMherst 7-5473
OKLAHOMA		
OKLAHOMA CITY	6715 North May Avenue	VIctor 2-4421
OREGON		
PORTLAND	2929 N.W. 29th Avenue	CApitol 8-0281
PENNSYLVANIA		
ORELAND	114 Montgomery Avenue	WAverly 7-4939
PITTSBURGH	3600 Laketon Rd.	CHurchill 2-6306
SOUTH CAROLINA		
COLUMBIA	3202 Devine St., P.O. Box 5435	ALpine 2-5437
TENNESSEE		
MEMPHIS	Room 9, 4711 Poplar Avenue	MUtual 2-3591
NASHVILLE	19th Floor, Life & Casualty Tower	CHapel 2-5469
TEXAS		
DALLAS	3200 Maple Avenue	RIverside 7-4296
HOUSTON	224 Park Tower Apts.	JAckson 8-1269
MIDLAND	P.O. Box 1567, Room 8, Westex Bldg., 212 W. Texas	MUtual 2-9257
SAN ANTONIO	109 Lexington Avenue	CApitol 4-7151
UTAH		
SALT LAKE CITY	2518 S. State Street	HUnter 4-5203
VIRGINIA		
RICHMOND 30,	5405 Patterson Avenue	ATlantic 8-1935 or 8-1936
WASHINGTON		
SEATTLE	2 Hanford Street	MAin 2-7661
SPOKANE	South 162 Post	TEmple 8-3621
WEST VIRGINIA		
SOUTH CHARLESTON	516 "D" Street	RI-4-9722
WISCONSIN		
APPLETON	510 West College Avenue	REgent 4-4536

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